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AMERICAN ENGINEER AND RAILROAD JOURNAL.

JANUARY, 1900.

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AN AMERICAN OBSERVER ABROAD.*

IV.

THE CREWE WORKS.

London & Northwestern Railway.

By W. F. M. Goss,

Professor of Experimental Engineering,

Purdue University, Lafayette, Ind.

The works of the London & Northwestern Railway at Crewe extend over an area of one hundred and sixteen acres, of which thirty-six are under roof. Within the works six thousand men find employment, and behind all and in all is the vigorous personality of the well-known Chief of Motive Power, Mr. F. W. Webb.

My trip to Horwich, concerning which I have already written, had prepared me for Crewe, for a similar business conception underlies both establishments. But the former is entirely a new creation, while the latter has been gradually brought to its present state from the small beginnings of nearly sixty years ago. Horwich, therefore, has the advantage of a more orderly arrangement, but Crewe is still the more extensive, and conducts a greater diversity of operations. Its forty or more shops include, besides those especially devoted to the construction and repair of locomotives and cars, others which serve in the production of various supplies and materials for the several departments of the road.

A rail-mill produces all rails needed for the tracks, work at the time of my visit being upon a 105-pound section rolled in lengths of 60 feet. The spring-steel used at Crewe, of which large quantities are required for the long flat springs of English cars, is all manufactured within the works. A fine shop, presenting a large unobstructed floor, and having a machine equipment near at hand, is employed upon switch, crossing, and special track work, while a neighboring department turns out great quantities of interchangeable equipment for switch and signal towers.

A general machine-shop bu.lds machinery for water-stations, new shop-tools of up-to-date design, cranes of various types for freight stations, baggage-lifts for passenger stations, high-speed steam engines for driving dynamos direct-connected, and makes repairs on the machinery of the company's tug-boats and steamers. I found this shop well filled with new work in great variety.

The massive steel castings of a powerful hydraulic press designed for steel forging occupied the heavier machines, and the parts of a large lathe were being assembled on the erecting floor. All castings, whether of iron or steel, are products of the works.

Another department makes dynamos and the smaller electrical fixtures and supplies needed for crane work, and for station lighting. Out of doors an extensive brick yard is operated, the product of which is entirely consumed along the line, and in a corner of the pattern-shop, which is railed off from the rest of the room, most excellent wooden arms and legs are made for employees of the road who have suffered mutilation in its service.

It was impossible in a single afternoon for one to see even the external form of so large an establishment, but my understanding is that so far as is practicable, all manufactured articles needed by the various departments of the road are made at Crewe under the direction of the locomotive department, the value of materials supplied by this department to other departments of road amounting in round numbers to $4,000,000 a year.

Four-Cylinder Compound Locomotive—London & Northwestern Ry.
Cylinders, High Pressure, 15 Inches; Low Pressure, 20½ Inches by 24 Inches Stroke.
Balanced on the Strong System.

An interesting feature of Crewe is its immense banks of

*For previous article see Vol. 73, page 375.

coal. The explanation is that the road uses somewhat more than a million tons of coal a year, that the possibility of strikes at the mines makes delivery at a constant rate so uncertain that a large supply must always be carried. The piles are formed within retaining walls constructed of the larger blocks of coal, with sufficient care to give a regular outline and a smooth exterior surface. They rise to a height of eight or ten feet only, and extend along the lines of track from which the coal was delivered. All are without covering. Similar but smaller piles are to be seen at intervals along the road, and when near stations the exterior walls are not infrequently decorated with a coat of whitewash.

Mr. Webb has 2,800 locomotives, the heavy repairs upon which are made at Crewe. Many very old engines are still in service, and consequently there is a large number of different types to be cared for. Seven hundred engines, however, have similar cylinders and similar boilers. The boiler shop contains long rows of repaired boilers, ready to go out on any engine of the class for which it is standard. Other details have in some cases been standardized to cover a still greater number of engines; for example, it is said that, "there are but two eccentrics on the whole road."

The new work in progress includes an installment of heavy simple engines, and an installment of four-cylinder compounds, the two classes being quite similar except as to cylinder arrangement and the details depending thereon.

These locomotives in common with the new engines of the Lancashire and Yorkshire, to which I referred in a previous letter, have a "center frame" which in its present form at least, constitutes a new element in locomotive design. The center-frame is a deep cast-steel member, extending longitudinally from the cylinders to a cross-brace back of the main axle. Its purpose is to provide support for a third bearing on the crank-axles, for which the straight portion between the cranks serves as the journal. With the addition of this bearing, the full length of the crank axle, except that portion which is taken by the wheels and the webs of the cranks, is utilized as journal surface, a condition made possible by the use of the Joy valve-gear and the consequent absence of eccentrics. The center-bearing is not allowed to carry any considerable portion of the weight of the engine, but is designed chiefly to resist the thrust of the cranks.

Nothing which I saw at Crewe interested me more than the new compounds, which are referred to by Mr. Webb as locomotives of the "Black Prince" class. I was especially fortunate in seeing a half-dozen of them coupled together, which had been pulled out fresh from the shops for the inspection of the directors, and a very fine and business-like procession they made. They are not large engines, as Americans measure size, but they are more powerful than any previously existing type on the London & Northwestern Road. The wheel arrangement is that of the "American type," the four coupled-wheels having a diameter of 85 inches, and the four truck-wheels a diameter of about 50 inches. There are two 15-inch high-pressure cylinders outside of the frame and two 20½-inch low-pressure cylinders inside of frame, all of 24-inch stroke. The cranks on the axles are opposite those in the wheels, thus making possible a perfect balance of the reciprocating parts, the whole arrangement, so far as cylinders, cranks, and reciprocating parts are concerned, being similar to that of the Strong, balanced, compound locomotive which was tested at Purdue two years ago, and with which the readers of the American Engineer are familiar.

The Joy valve-gear of the engines of the "Black Prince" class takes its motion from the low-pressure connecting rod and communicates directly with the low-pressure valve-spindle, all as in simple engines. But the low-pressure valve-spindle is extended through the front of the valve-box where it connects with a rocker which serves to transmit motion to the high-pressure valve-spindle. Thus the valves of the outside cylinders are driven from the motions of the inside cylinders.

Comparing the new compound with the highest development of the Webb three-cylinder compound, which is represented by the class to which belongs the "Empress Queen," exhibited at Chicago in 1893, one finds that the engines are quite similar in several important respects. They have the same diameter of drivers and practically the same cylinder volume. The new engine is, however, designed for a pressure of 200 pounds, which is 25 pounds more than is carried by the "Empress Queen," and it is probable that its boiler has a greater area of heating surface, though judging from appearances alone the increase is not great. Since the new engine with dimensions but little increased as compared with those of an older type is regarded as much more powerful than any of the previously existing types of the road, it is evident that the designer attaches no small significance to those features of the four-cylinder compound which are new to his practice.

The English, generally speaking, are not now interested in the compound problem, but the vigor with which Mr. Webb has labored in its development has been uninfluenced by any lack of sympathy which he may have encountered. He began his experiments twenty-one years ago, and three years later built at Crewe his first three-cylinder compound, a type now generally known by his name. The number of compounds was soon after increased to thirty. Following this first lot there appeared at various intervals between 1882 and 1899 five other lots of from ten to eighty engines each, making the total number of compounds now in service one hundred and eighty, differences in the engines of the several lots representing progress in design, or being in response to the requirements of different classes of service. The twenty, four-cylinder engines now in process of erection will increase the number in service to two hundred. In a paper before the June meeting of the Institution of Civil Engineers, Mr. Webb describes his various types and testifies as to their satisfactory performance in service.

FLEXIBLE STAYBOLTS.

By F. W. Johnstone.

Superintendent Motive Power and Machinery.
Mexican Central Railroad.

I have for a long time been working on the staybolt problem and consider it very important.

The small blue print under date of Sept. 7th, 1899 (Figs. 1 to 4) represents the flexible staybolts as we are now applying them to locomotives on this road. We use very bad water on some sections of this road and the number of broken staybolts discovered each month is simply enormous. In one lot of nine engines running in a hard-water district we renewed 1,114 broken staybolts during the three months of August, September and October, 1899. All of our engines are inspected every thirty days, and broken staybolts are renewed immediately after the inspection has been made. These nine engines are all comparatively new, having been built since the spring of 1897. They were built by one of the best locomotive works in the United States and the best known grade of staybolt iron was used. The staybolts are ⅞ inch in diameter except the four upper rows on the side sheets, which are 1 inch in diameter, and all staybolts are spaced 4 inches centers. These engines carry 180 pounds of steam.

I estimate that we will have to replace more than 20,000 staybolts during the year 1900. Some of these bolts, which are easy of access, can be put in at a cost not to exceed $1.00, while others will cost $10.00 apiece, due to the labor of taking down and replacing such parts as the reverse lever quadrant, springs and spring rigging, etc. This matter of broken staybolts has become so serious that we were obliged to devise some method of reducing the cost of renewals and avoid throwing the engines out of service every thirty days to make these renewals, and we have settled upon these flexible staybolts as the remedy for the evil. Not one staybolt out of five thousand is found broken next to the firebox sheet; they are invari-

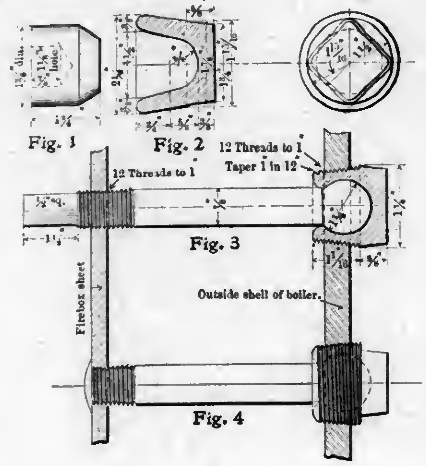


Fig. 1 Fig. 2 Fig. 3 Fig. 4

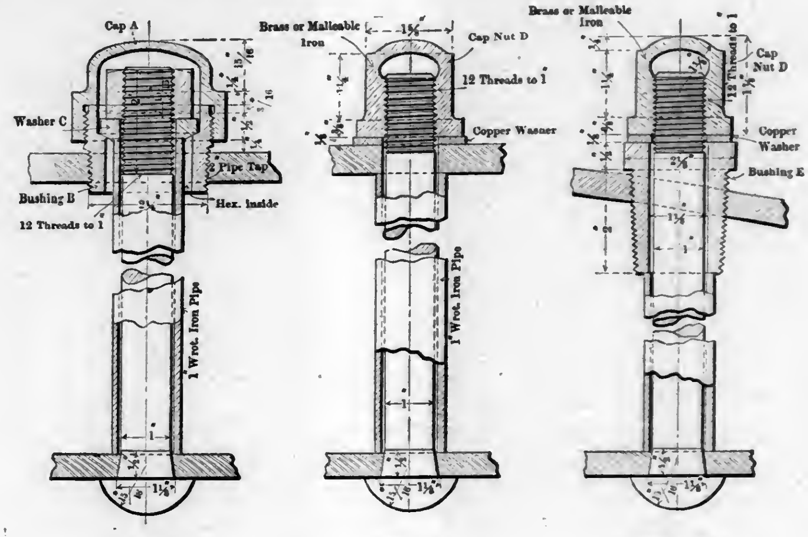


Fig. 8 Fig. 9 Fig. 10

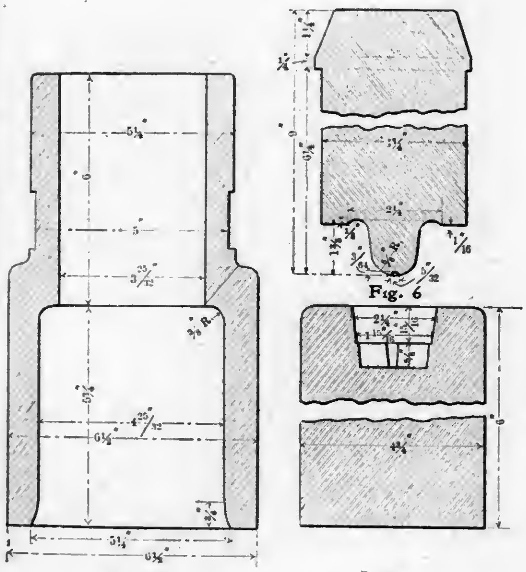


Fig. 6

Fig. 7 Fig. 5

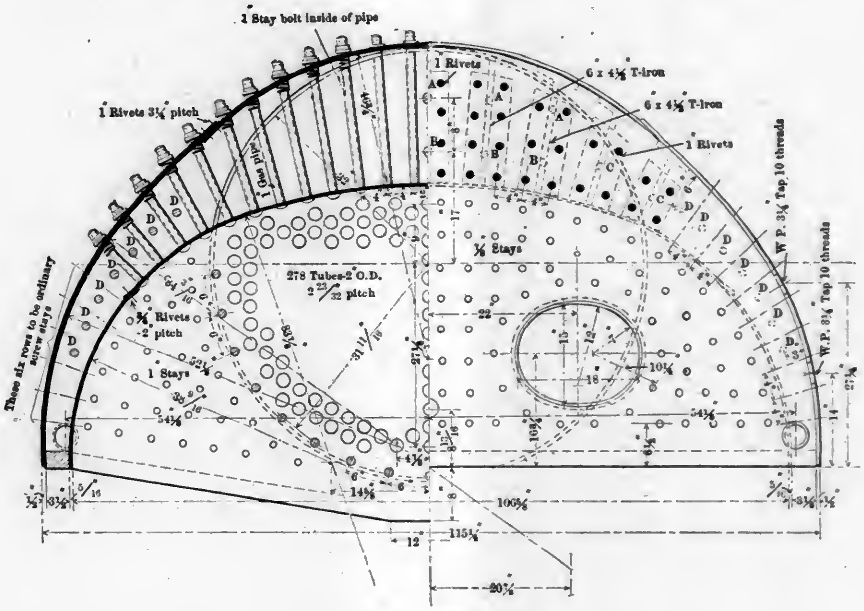


Fig. 12

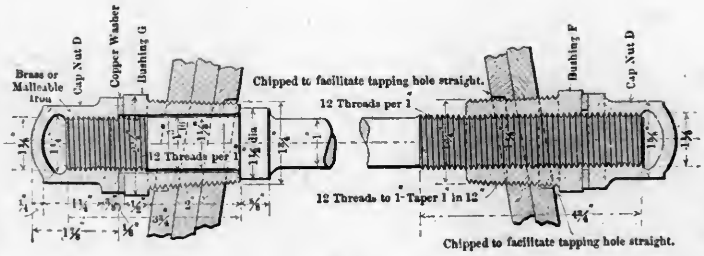


Fig. 11

ably found broken just at the inner edge of the outside sheet, and if we can make this portion of the staybolts flexible so that the bolt can adjust itself to the expansion and contraction of the firebox sheet, we shall overcome the difficulty of broken staybolts, and I believe we have accomplished this end. We have put a number of these staybolts in service and are putting them in every day, especially when renewing staybolts in the upper rows, as we find the largest number of them broken in the upper front and back corners in the side sheets, although we find broken staybolts distributed all over the firebox, even in comparatively new engines. Our present method of manufacturing these staybolts is as follows:

We use mild steel in bars 1¾ inch diameter, a piece 1¾ inch long is cut off of this bar and one end roughly hammered into a square, Fig. 1. These plugs are then put into a jig and a hole 1⅛ inch in diameter by ⅞ inch deep, drilled in the end. A number of the plugs are then heated together in a furnace, and as we have no drop hammer we use one of our steam hammers for forming the plug. The die, Fig. 5, in which the plug is formed, is placed upon the anvil of the steam hammer. The heated plug is dropped into the top of the die and a punch, Fig. 6, which is already inserted in the guide or holder, Fig. 7, is placed over the die, and one blow of the hammer finishes the plug in the form shown in Fig. 2. We find it necessary to put two handles on the punch guide, as it was too heavy for one man to handle.

The staybolt proper has a ball formed on the end in an ordinary bolt-heading machine; the thread on the other end of the staybolt is cut in an ordinary bolt cutter; as the staybolt is free to revolve in the plug, there is no necessity of the thread on the staybolts being cut in unison with the thread on the plug. The staybolt is then put into a chuck fitted to a small lathe, the tool rest of which is so arranged as to revolve around a pin immediately under the center of the ball. The tool post is fed up against a stop, and then the tool is moved around in a semi-circle by a hand lever. This

turns the ball on the end of the staybolt perfectly true and does the work very rapidly. The next process is to heat the plugs, as shown in Figure 2, and crimp or close them down around the ball on the end of the staybolt. At present we are crimping the plugs by hand, using a light flatter and light sledge, but we have designed a machine for doing this crimping by power, and when this is perfected the closing will be done by cheap labor. The last process is to cut the thread on the plug. This is done in a lathe, the thread being finished by running a solid die over the plug. The whole process of manufacturing these staybolts is done by cheap labor, and the cost of labor for manufacturing a complete staybolt does not exceed nine cents in gold.

I have made several tests of these staybolts and find that when the plug is screwed through the plate until the inside edge of the plate is opposite the center of the ball so that the plate offers no re-enforcement to the plug, it requires more than 20,000 pounds to pull the ball out of the plug. Where the plug is screwed into the plate, as shown in Fig. 3, the plate re-enforces the plug to such an extent that the bolt breaks under a strain of from 28,000 to 30,000 pounds without even loosening the ball in the plug. As these staybolts have to resist a strain of only about 3,000 pounds in service, we find that the staybolt has a factor of safety of from six to ten, and is therefore perfectly safe.

In tapping out the holes in applying these staybolts we use a hollow tap for the outside hole, inserting a rod to guide the tap. In tapping the hole in the firebox sheet, where we find it necessary, we use a bushing on the outer end of the tap simply to guide the tap, and as there is no necessity for having the holes tapped in unison with each other, they can be tapped separately and there is no danger of stripping the thread on either end of the staybolt.

In applying the staybolts, one man screws in the plug from the outside, while another man on the inside of the firebox turns the staybolt. The plug and staybolt are free to adjust themselves to the threaded holes in the two sheets, and are readily screwed into place. After the end of the staybolt is cut off on the inside of the firebox it is hammered over in the usual way, a holding-on bar being placed against the back of the plug on the outside of the firebox.

In Fig. 9 is shown our standard crown stay. This consists of a through bolt with a button head under the crown sheet, a spacing piece formed of 1-inch gas pipe between the crown sheet and the shell of the boiler, and a cap nut screwed on the upper end of the stay with a copper washer under the nut. We have a number of Belpaire fireboxes, which have been running for several years, equipped entirely with these crown stays, and we find them by far the most satisfactory arrangement of crown stays we have ever tried. When it becomes necessary to remove one or more of these stays for the purpose of straightening the sheet, we take them out in a few minutes, make the necessary repairs and replace the same bolts. Heretofore we have used sling stays in the four front rows, allowing some flexibility to accommodate the expansion of the flue sheet, but as these sling stays occupied so much of the space, we found it impossible to get at the crown sheet from the barrel of the boiler for the purpose of scraping off mud and scale which accumulates on the top of the sheet. To overcome this difficulty we have devised a flexible crown stay, as shown in Fig. 8. These flexible stays take the place of the four rows of sling stays, and we are now getting some locomotives built by the Baldwin Locomotive Works in which the four front rows, two back rows and two rows on either edge of the crown sheet are equipped with these flexible stays, Fig. 8, all the rest of the stays being of the rigid form, as shown in Fig. 9.

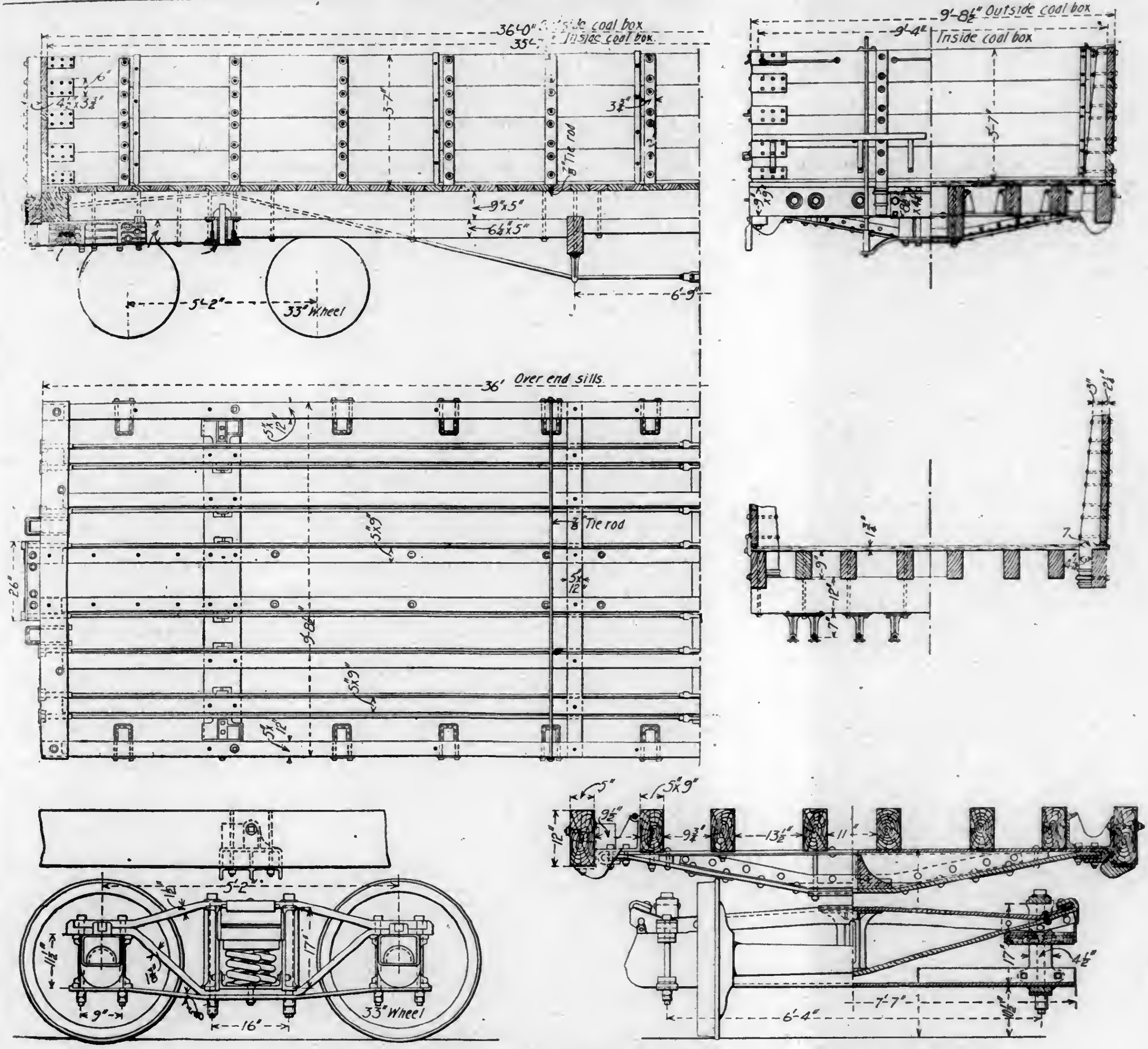
Referring to Fig. 8, it will be seen that we use a spacer formed of 1-inch gas pipe, a washer resting on the top of this spacer and a nut screwed down firmly on the top of the washer. This insures a proper fit between the button head of the crown stay and the under side of the crown sheet, but it will be seen by the construction of this crown stay that the sheet is free to expand upward, carrying the crown stays with it, as in the case of the sling stays, and when the boiler has become warmed up and the steam pressure has accumulated, the outer sheet expands and the washer seats itself on the shoulder provided in the bushing. This crown stay is also readily removed and renewed without having access to the inside of the boiler.

Figure 10 shows the radial stay which we propose to use in the construction of wide fireboxes. The principle is exactly the same as in Fig. 9, but we introduce the bushing, E, and form a steam joint with the copper washer between the cap nut, D, and the bushing, E. Figure 11 shows the style of cross stay that we have adopted. In trying to design a cross stay which could be readily removed and replaced without destroying the ends of the stay or the threads in the boiler plates when it becomes necessary to clean the crown sheet, we designed a number of different styles of these cross stays and submitted them to Mr. Vauclain of the Baldwin Locomotive Works, as we wished them introduced into the engines now being built by these works for this company, and upon the last suggestion by Mr. Vauclain we have now got it down to its present form and feel satisfied that it will answer all of the requirements. It will be seen that this cross stay can be taken out and replaced without removing the crown stays, or having access to the interior of the boiler.

The process of introducing this stay is as follows: First, screw in the bushing, F; second, screw the cross stay into the bushing, F; third, screw in the bushing, G; fourth, back off the cross stay until the collar is against the bushing, G; fifth, screw on the cap nuts, DD.

Two fireboxes, one a Belpaire, and the other wide, were designed so that a comparison could be made on the same class of engine and the cost obtained, with the view of introducing some of the wide fireboxes for trial on this road. These boilers give examples of the application of the crown stays above described. By referring to the wide firebox, Fig. 12, it will be seen that the four center rows of crown stays are exactly like Fig. 9, tapering copper washers being used under the cap nuts, and the other ten rows on either side of these four rows are provided with crown stays as shown in Fig. 10. With this arrangement we have a firebox practically equipped with flexible stays, and we may feel reasonably assured of having no reports of broken staybolts in boilers of this construction. The only rows of ordinary screw staybolts in the side sheets are down close to the mud ring. There is little probability of these giving trouble, due to the reduced amount of expansion in so short a distance, but should these staybolts and those in the throat sheet and back head give any trouble in service we would renew them with the flexible staybolts first described, and we would have a boiler with the firebox perfectly stayed and yet flexible in all directions. Such a firebox should not develop cracks as readily as with the ordinary system of staying; certainly we should feel no uneasiness as to the safety of this boiler, and in these days of high boiler pressure that is a very important consideration.

Mr. Edwin M. Herr has been appointed General Manager of the Westinghouse Air Brake Company. He has been Assistant General Manager since he left the Northern Pacific as Superintendent of Motive Power. He has instituted a number of extensive improvements in the manufacture of the air brake equipment and is engaged upon the application to the air brake business of the principles which made his success in railroad work. This is a pleasing recognition of his value, and the result will doubtless be to relieve Mr. H. H. Westinghouse, Vice-President, of many of the details of the affairs of the company. Mr. John F. Miller has been appointed Assistant Secretary.



36-Foot 80,000-Pound Coal Car with Siding Outside of the Stakes and Simplex Bolsters. Hocking Valley Railway.

36-FOOT 80,000-POUND COAL CARS.

Hocking Valley Railway.

S. S. Stiffey, Master Mechanic.

These cars are of wood, and are arranged to give large cubical capacity by placing the sideboards outside of the stakes. Their weight is 29,000 pounds.

In designing large capacity cars it is a problem to obtain sufficient cubical capacity without increasing the length more than is desirable or increasing the height of the sides to such an extent as to be inconvenient in loading and unloading. Therefore the construction here described undoubtedly offers several advantages.

In this design Mr. Stiffey was confined to a certain height and to the length of sills of the cars of 60,000 pounds capacity which were in use previously. To meet these conditions the number of longitudinal sills was increased from six to eight and large stakes were used, with sufficient width to extend a toe down against the inside face of the side sill. To prevent the side sills from rolling out under the strain which tends to bulge the sides of the car, two ⅞-inch tie rods are introduced nearly over the needle beams and across the car near the floor line, the effect of which is to tie the side sills together at the top.

The principal reason for introducing two additional sills was to prevent the floor from crushing down when hydraulic pressure is applied to the sides of the cars to clamp them to the rails during the operation of dumping on the Brown Hoisting and Conveying Machine Company's machine at the docks where the cars are placed in cradles and turned over bodily in unloading.

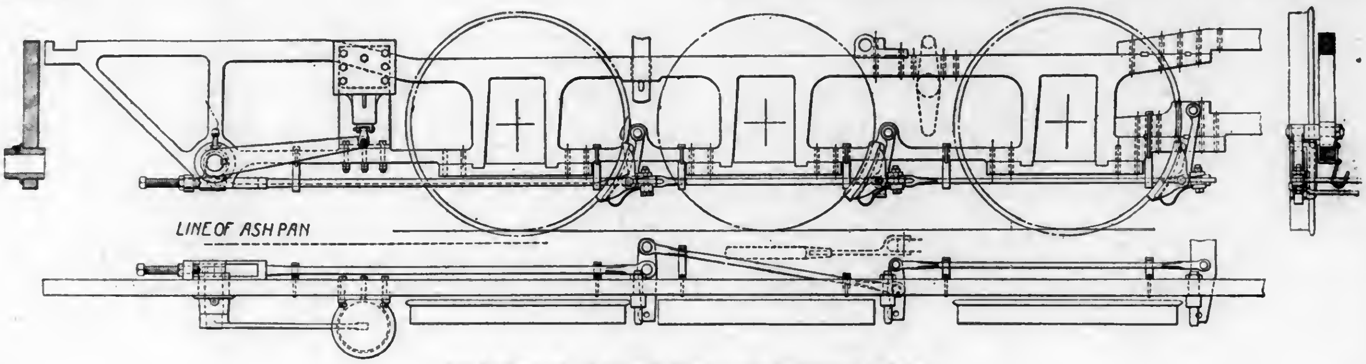
The length of the car over end sills is 36 feet, the width inside the box is 9 feet 4 inches, and the height of the sides is 3 feet 7 inches. By means of the arrangement illustrated the original capacity of the 60,000-pound cars, which was 870 cubic feet 1,242 cubic inches, has been increased to 1,191 cubic feet 792 cubic inches, these measurements being taken with the assumption that the cars are level full.

The truck which was designed for this car is also illustrated in the engravings. There are now 2,500 of these cars in service and Mr. Stiffey states that they have brought out many favorable communications from people interested in increasing the

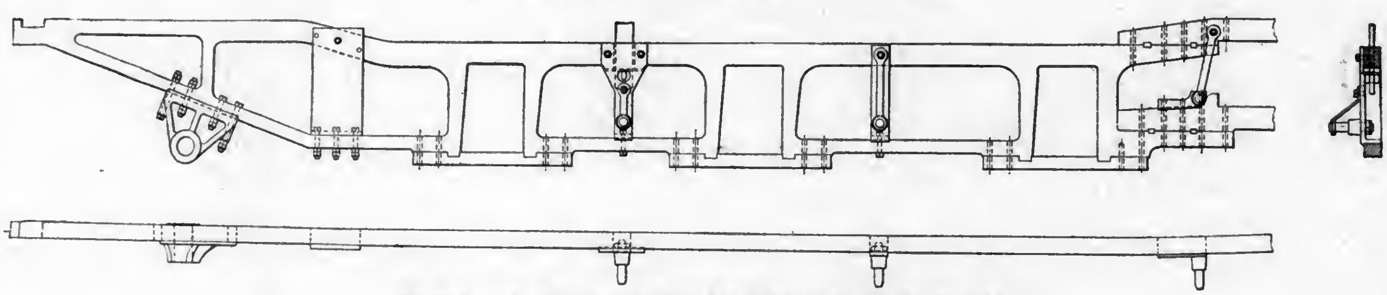
capacity of coal cars. These cars are equipped with steel bolsters. The Simplex bolsters were applied to 2,000 of them, as shown in the engravings, and the remainder have bolsters made by the Pressed Steel Car Company. The cars have the M. C. B. 5 by 9-inch axles and M. C. B. springs. The malleable castings were made by the Dayton Malleable Iron Company, including the Dayton malleable iron brake lever, Dayton brake wheel and the Hoey draft rigging. It should be stated that the bolsters were designed to carry the cars free of the side bearings.

A GREAT IMPROVEMENT IN DRIVER BRAKES.

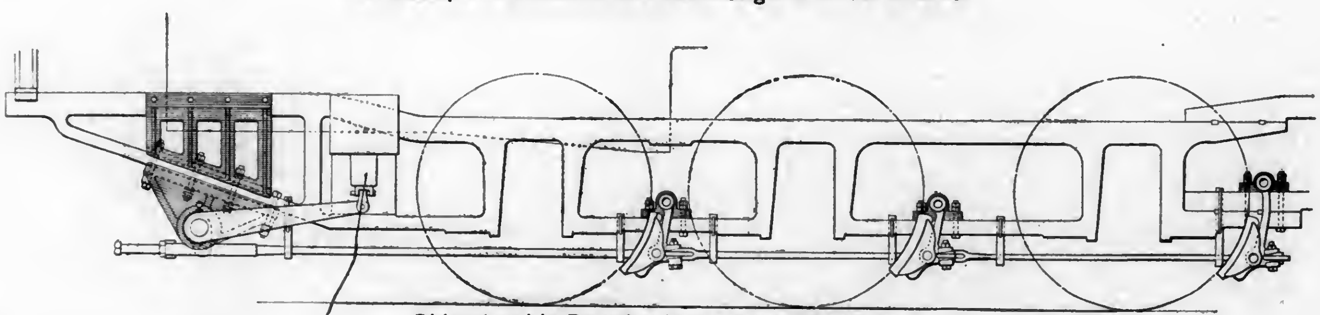
The clumsiness and unnecessary weight of the usual driving brake attachments to locomotives is shown in an almost startling way by a glance at a well designed arrangement, and it seems strange that the improvement was delayed so long. It surely was needed badly enough. In this case, the air brake has been considered, as it ought to be, as an integral part of the locomotive, which is to be provided for in the design of the details instead of putting it on as an attachment, as if an afterthought upon the completion of the construction in other respects.



An Example of Good Design in Driver Brakes.



An Example of Common But Bad Design in Driver Brakes.



Objectionable Practice in the Use of Castings.

These engravings show two examples of very common practice contrasted with a new arrangement which does not involve any new principle except a complete provision for the attachment of the brake in the construction of the frames. The new plan was worked out by the American Brake Co., for new ten-wheel engines for the Chicago, Rock Island & Pacific. The old arrangement makes use of various castings and forgings of different shapes, and is attached by means of a large number of bolts with double nuts.

The hanger support between the middle and rear pairs of driving wheels is of special construction necessitated by the construction of the frame when a hanger link is required for the spring equalizer. It will be observed that in order to apply these plates to the frames, without requiring too large and objectionable bolts through the frames, hanger links are required throughout and the work is thereby greatly complicated and the number of bolts materially increased. Cross section views are shown which, together with the plan view, give a good idea of the complications which arise from the necessity of applying driver brakes to such frames.

Mr. R. H. Soule has resigned as Western representative of the Baldwin Locomotive Works at Chicago, to re-enter railway service. Mr. Soule was formerly Superintendent of Motive Power of the Norfolk & Western, and has been with the Baldwin Company since August, 1897. Mr. Soule is an ideal motive power officer and we shall congratulate the road which is fortunate enough to secure his services.

Mr. S. P. Bush has resigned as Superintendent of Motive Power of the Pennsylvania Lines, Southwest System, effective January 1, to accept the position of Superintendent of Motive Power of the Chicago, Milwaukee & St. Paul, which position was made vacant by the resignation of Mr. J. N. Barr, who went to the B. & O. Mr. Bush is but thirty-six years of age and is a graduate of Stevens Institute. He entered the service of the Pennsylvania in 1884 as special apprentice, and has worked his way up to the very important place he holds with the foremost motive power men of the country.

Mr. William Wright, General Foreman of the Vandalia at Terre Haute, has been appointed General Superintendent of the McKees Rocks plant of the Pressed Steel Car Co.

This adds an appreciable weight and places most of it very unfavorably, at the back ends of the frames. Now that so much study is given to the removal of unnecessary weight, the possibility of saving about 900 pounds, which is done by the new plan, should recommend it to locomotive men generally. This represents the weight which may be saved when the heavy fulcrum castings and cast frame braces are displaced by the light parts forged to the frames. The drawing of the old plan does not include the heaviest castings that are often used between the horizontal and inclined members of the frames. Furthermore, the new arrangement has the appearance of being designed instead of the apparatus being "thrown at the engine," as one motive power officer put it, on glancing at these drawings.

The Rock Island method employs fulcrums in bosses forged upon the frames, and it is clear that a great reduction in the number of parts is effected and at the same time there is a material gain in strength, and probably no increase in cost. The use of auxiliary bolts is avoided and the strength of the frames is not sacrificed by drilling large holes through them. The design is one which will recommend itself to all mechanical engineers entirely aside from the important consideration of weight. The advantages of these bosses are specially clear in connection with cast steel frames.

The fulcrum of the cylinder lever is made a part of the frame and is provided with a stiffening brace vertically over it between the two bars of the frame. This takes the place of the usual spacing casting which also supplies a bearing. It is not more difficult to make than the struts which are welded into the frames of heavy engines at the equalizers and once made in the frame it is permanent. This Rock Island engine has 110,000 pounds on the driving wheels and a braking force of 82,500 pounds, with 12x10-inch cylinders. The cylinders are placed with their axes vertical, which is one of the minor advantages gained. The merits of the improvement are so clearly seen in the drawing as to lead to the conclusion that it, or something similar, will become common practice. The engravings illustrating the usual practice represent the best of common practice, and it is safe to place the saving of weight, usually possible, at 1,000 pounds. The saving, however, is not in weight alone but in maintenance. This new plan is recommended by the American Brake Co. and is illustrated through the courtesy of the Westinghouse Air Brake Co. It is not entirely original, as the later engines of the Pennsylvania have excellent designs of driver brakes involving the principles here described.

ENGINEERING IN THE NAVY.

PRESIDENTIAL ADDRESS BY ADMIRAL GEORGE W. MELVILLE.

American Society of Mechanical Engineers.

The position and life work of Admiral Melville, Engineer-in-Chief of the United States Navy, promised an instructive and valuable address, and it was forceful, inspiring and satisfactory as showing the influence of the engineer in the high development and efficiency of our naval protection.

Every American was naturally proud of the fact that the first successful steam vessel was the work of an American engineer, but it was not so generally known that the same American, Fulton, designed the first steam war vessel of any navy. He referred to the "Demologos," intended for use in the War of 1812, but not completed until 1814, after the close of that conflict. The real beginning of naval engineering, however, was when the steamer "Fulton" was built in 1836 and in that year Mr. Charles H. Haswell, the "Nestor of engineering in this country," became the first chief engineer in our navy. The wonderful rapidity of naval engineering development was strikingly shown by reference to the fact that the first chief engineer was still alive, in full possession of his faculties and in the active practice of his profession to-day.

High tribute was paid to Isherwood, who had demonstrated the then unknown fact that under the conditions obtaining in the case of the U. S. S. "Michigan," with a slow-moving engine and low steam pressure, a ratio of expansion was soon reached, beyond which any increase would cause an absolute diminution of economy, instead of an increase, as would have been predicted from a strict adherence to Mariotte's law.

Among the other engineer contributors to naval progress was George Westinghouse. The wonderful achievements of Mr. Westinghouse, both as an inventor and as the creator of great industrial works, entitle him to be called the "Napoleon of industrial engineering." The high efficiency of the navy was due in a large degree to the competent engineers and to their excellent training at the Naval Academy, testimony to the high character of which was seen in the fact that the Government had been unable to retain the services of a large number of graduates who were called to take positions of responsibility in other fields of work. Many of these men were prominent members of this society. Not all the talent had departed, however, and the speaker made graceful acknowledgment of the support of his subordinates.

The most important steps in the improvement of marine machinery were reviewed, one of the most noteworthy of which was the decision to employ water-tube boilers exclusively for all classes of vessels. This conclusion was reached very recently, and the reasons are given elsewhere in this issue. They have an important bearing upon the future of naval construction. Steam pressures were gradually rising and present plans included the use of 250 pounds at the engines and some 25 or 50 pounds more than that at the boilers. While it was not believed that finality had been reached in the development of marine machinery, it was thought that the designer had little room in which to work with present types of engines except in the details. Rather guarded reference was made to the steam turbine. The performance of the "Turbinia" justified most careful study and further experiment, and it was encouraging to know that the steam turbine in this country was in the hands of so competent an experimenter as Mr. George Westinghouse, who is now engaged upon the construction of a unit of 2,000 horse power on a single shaft.

The war with Spain had shown the very great value of the repair ship, "Vulcan," and the distilling ships, as adjuncts of a fleet. The "Vulcan" carried the first cupola ever set up for operation on board ship, and this ship was the equal of anything, except a very large repair yard. She was an example on a large scale of taking the tool to the work instead of bringing the work to the tool. The distilling ship "Iris" actually furnished over 100,000 gallons of fresh water per diem. Her bunker capacity of 3,000 tons of coal gave her a potential capacity of distilled water of 60,000 tons, or as much as 12 of the largest "tankers." In the battle of Santiago the engineer stood out, a most prominent figure. The brilliancy of the victory was largely due to the skill and foresight of Chief Engineer Milligan of the "Oregon" in insisting that all of the boilers of that ship should be ready for action all the time, although others had steam on but half the boilers, and where it could be done half the engine power was laid off. This case was direct proof that, however admirable as a great fighting machine, the battleship is useless except in the hands of trained engineers. This led to reference to the recent change in the regulations whereby every future officer on our war vessels is to be trained as an engineer. If the new law was to be administered with regard to its plain intent, ours would be the most efficient navy in the world, but disastrous results would follow any indifference to the purpose of the law on the part of those in authority.

The whole tenor of the address was such as to inspire additional confidence in those who are responsible for this part of the nation's defences. It was particularly appropriate, as the speaker said, that one of the engineers of the old school should at the close of this chaper in the history of naval engineering give a review of some of its more important facts, and the manner in which it was done added to the high esteem in which Admiral Melville is held.

CORRESPONDENCE.

STAYBOLTS.

Editor American Engineer and Railroad Journal:

The whole secret, I believe, of the staybolt question is the larger water space. We have proved beyond any doubt that, by increasing the width of the water space, and consequently the length of staybolts, we have increased their period of usefulness about thirteen times without the slightest change in the material.

We are still drilling tell-tale holes in the ends of staybolts, and even on old boilers we drill them and afterward test them. In this way a great many partially broken staybolts are discovered.

We are not now putting in corrugated or cupped side sheets in our fireboxes, because we found that the cupped sheets had a life of but 18 to 20 months' service, and, while these sheets have lasted fully as long as straight sheets, we met with difficulty in patching them and found that this could not be done successfully, while with a straight sheet a portion may be cut out and replaced with a patch which is, of course, greatly in favor of the straight sheet.

In riveting up our mud rings we used to put the head of the rivet on the inside of the firebox. We now put the head on the outside of fireboxes, countersinking the sheet inside and driving the rivets up flush. There are several points in favor of this. The first is, that by getting rid of the head there is no obstruction whatever to putting up side grates. We used to have to chop out the side grates for the head. Another advantage is that the corrosive matter does not now stick on top of the heads and cause the sheets to rust out; also, by this method we have quicker work, as the rivet is hammered down flush. The riveting is done on the most important sheet in the firebox inside, where it is likely to give us less trouble from corrosion than if it were on the outside.

Chicago, Ill., ROBERT QUAYLE,
Nov. 27, 1899. Superintendent Motive Power
Chicago & Northwestern Ry.

STAYBOLT PROGRESS.

Editor American Engineer and Railroad Journal:

The article in the American Engineer and Railroad Journal of December, under the above caption, was peculiarly interesting to the writer on account of some tolerably thorough investigations concerning staybolt practice made in the winter of 1892-93, the results of which were published in the proceedings of the Southern and Southwestern Railway Club for April, 1893. At that time these results, judging from subsequent correspondence and references, attracted considerable attention, but in seven years' time the report referred to has become ancient history and forgotten, the subject matter investigated all over again by others produces the same results and recommendations to be again forgotten. That the same thing has been going on for generations is plain from the fact that staybolts of the form recommended in the article referred to last month, and in the report of April, 1893, have been found in ancient locomotive boilers that were being cut up years ago. Some thoughtful men had investigated and reached the same results years before, the results to be lost and buried. Our text-books and treatises, our technical teachers, etc., are largely responsible for this.

The writer, being familiar with the rules and formulae, tests, government and Lloyd's rules, etc., was rather taken aback at one time when some staybolts were found broken in three pieces. The boilers in which these were observed were fitted with circulation sheets, and the stays referred to were found broken off at the outside sheet and again at the circulating sheet, through which they had been tapped. Here was an object lesson—the steam pressure and its strains had had nothing to do with the second fracture, as all strain on the stay was relieved when the first fracture occurred.

The next thing that came to the writer's attention in following up staybolt breakages was that bolts broken at the same places in boilers of the same classes and designs, when examined in place, or by marking their position before removal, showed that they had been broken off in the same way. For instance, the staybolts at the reverse bends in the sides of radial stay fireboxes near the middle always showed that vertical bending had broken them, because the line of final fracture, or "let go," was always horizontal. Similarly, in certain long fireboxes the end stays showed a vertical line of fracture, proving that horizontal bending had been their ruin. Different writers, who have touched on the subject of expansion of locomotive fireboxes, have considered the vertical movement of the box or lifting of the crown sheet, but I have yet to see the first mention of the longitudinal expansion as a factor in the staybolt breakages. In a deep, short firebox of the old style between frames, the differences of longitudinal and lateral expansion are so small that no trouble to speak of comes from them, while the differences in vertical expansion are considerable. With modern shallow fireboxes, ten and eleven feet long the opposite is the case, and it is the longitudinal expansion which does the most damage in many designs of boilers.

The writer well remembers the pride with which a prominent master mechanic some years ago pointed to a large boiler in the shop wherein all the portions of the firebox where broken stays were troublesome were strengthened by doubling the number of stays—placing them 2¼ inches centers—with the firm conviction that "now, by joining, we won't be worried any more with broken staybolts." The boilermaker and designer places stays, bolts, braces, etc., to make the boiler as rigid as possible, and ignores the destructive effect of the expansion and contraction; or, if he does anything to meet it, it is as above illustrated, to try and master it instead of providing for it intelligently. To attempt to overcome or master the expansion of a boiler due to heating is absurd, and, when indulged in, is really due to lack of appreciation of the irresistible power to be contended with.

Experiments made in England with cylindrical, corrugated fireboxes, showed that, to shorten a "Fox" corrugated firebox 30 inches diameter, one thirty-second of an inch required a pressure of over 300 tons. What would be the power exerted by a flat firebox sheet 10 feet long, well held to its place, and prevented from buckling by numerous staybolts, when due to, say, 1/16 inch of scale, it must expand, say, 1/32 inch in length more than the outer shell? The power is there and is inevitably absorbed by crushing the sheet or breaking the stays; then, when the cooling off process comes, the sheet having been previously shortened, is stretched again. Leaky seams and cracked and pocketed side sheets are the inevitable result.

Inquiry made in 1892 from 22 prominent and progressive railroads brought out the fact that on some roads staybolts had to be tested every week, the renewals being a heavy source of expense and delay to the engines; while on other roads broken staybolts were rare, it being found sufficient to test them once a year. Why the difference? The trouble from broken stays was found to be directly proportionate to the amount of scale forming matter in the water. Where the firebox sheets became rapidly incrusted, so that the inner sheet would be many degrees hotter than the outer shell, there the broken stay and cracked sheet and leaky flue were household words. Where the water was soft and good, so that little or no deposit ever formed on the sheets, both sheets could heat up and cool down together, broken stays and cracked sheets were rarities, and staybolts only had to be tested once a year. It is the repeated bending that breaks the staybolts, assisted of course, by the strain.

A wire rope, if the ends could be secured steam -tight in the sheets, would make an ideal staybolt.

But flexibility in the staybolts is only half the battle. The firebox sheets must expand and contract in all directions more rapidly than the shell sheets; this expansion and contraction should be considered in the design of the boiler at every brace and stay rod, at every seam and corner of the firebox, giving easy curves and bends at all the corners with room for the boiler to breathe vertically, horizontally and laterally. The recently illustrated boiler with a single large corrugated, cylindrical firebox, seems to offer a remedy for all these ills, if it does not introduce other evils of perhaps a worse nature. A few years' hard service for such boilers in districts where the water bears scale and boilers have to be worked to their utmost will bring the answer.

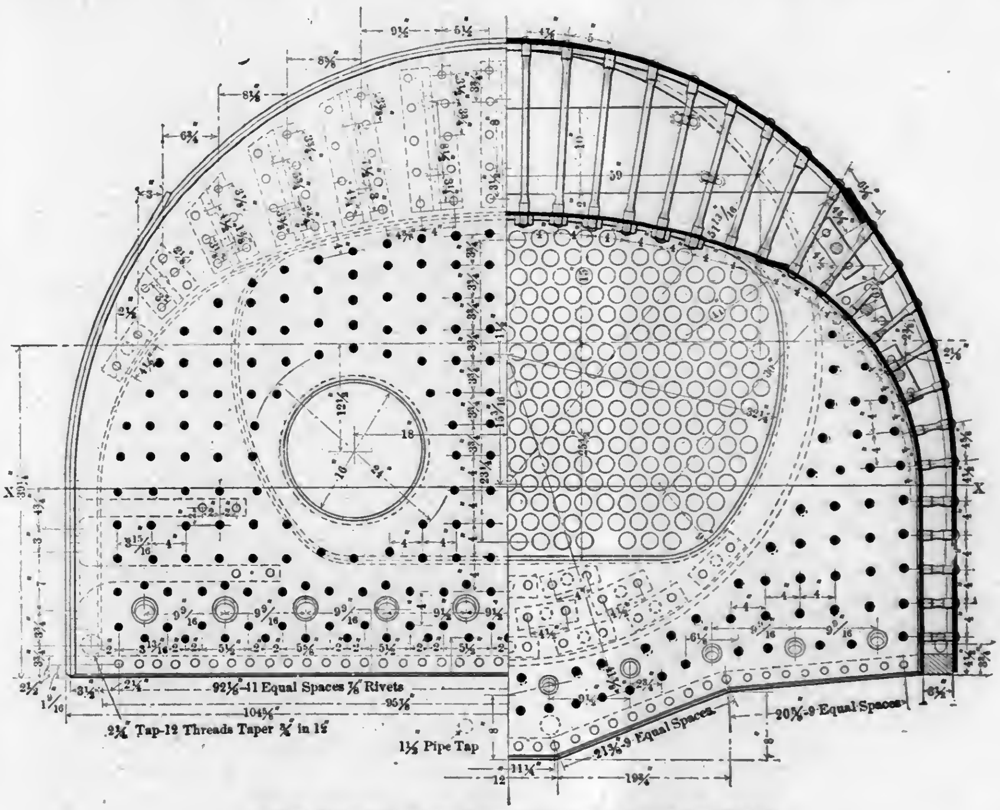
Roanoke, Va., R. P. C. SANDERSON,
December 16, 1899. Master Mechanic,
Norfolk Western Ry.

STAYBOLT PROGRESS.

Editor American Engineer and Railroad Journal:

I have read with great interest the article on Staybolt Progress in the December issue of your paper, as I have been investigating this matter for some time. While, in a general way, my results coincide with those given, my observations lead me to somewhat different conclusions in some instances. Service tests are undoubtedly the most satisfactory for determining the values of different iron, but they require a long time, in fact, years, to obtain results. In the meantime, the particular brands tested may go out of the market, one instance of this kind happening recently. Vibration, or other tests that will give uniform results under conditions approximating service conditions, offer the best means of solving the many mooted questions arising from the use of staybolts. As stated in the concluding paragraph of the article referred to, the present form of vibration test is not satisfactory, as the results vary too widely; on the other hand, with even the extremes of variation, they point conclusively to certain deductions, which are of great value, and the improvement of apparatus and methods will soon evolve something more satisfactory now that the value of such tests is becoming widely recognized.

The length of staybolt is a decided factor, and, where possible, the water spaces should be made large. There are limits, however, to this increase. On most large roads, nowadays, there is a demand for heavy engines capable of pulling a given tonnage on certain runs. The strengthening of bridges has not kept pace with the demand for the heavier engines, so that in designing such engines every superfluous pound of weight must be dispensed with. The increasing of water spaces runs up weight very rapidly, especially on wide firebox engines. Another limiting factor is due to the steaming properties. Of two engines otherwise similar, that having the less water space can furnish the most steam when forced. Under no consideration should they be less than 3½ inches, and as much wider as above limits allow.



Wide Firebox with Semi-Circular Outside Shell.

The form of boiler is almost as important as the length, as regards the life of staybolts. All reverse curves, curves of short radii, and variations in contour between the outer and inner sheets should be avoided. Among the many advantages of the wide firebox extending over the wheels is the entire elimination of these factors. The outline illustrated in a former article shows the first step toward doing away with short bends and dissimilar contours, the outline being composed of a series of tangent curves. The enclosed drawing shows the next step. Above line X—X, the outer shell is a true semi-circle, and is an improvement, in that it is self-contained. The inner sheet opens the water leg gradually, and follows the contour of the outer sheet closely. Our experience has proved this design to be a saver of staybolts.

A B C D E F G H

The records of vibration tests show some results hard to account for. Six different shapes of staybolt were tested, with the following results as regards ultimate life, the order indicating the relative standing:

1. C. B. & Q. form, with drilled tell-tale hole.
2. Bolt threaded entire length; drilled tell-tale hole.
3. C. B. & Q. form, punched tell-tale hole.
4. C. B. & Q. form, no tell-tale hole.
5. Threads stripped between sheets; no hole.
6. Upset head from ¾ inch to 1 inch; no hole.

The special form of bolt as used by C. B. & Q., when having a drilled tell-tale hole, was undoubtedly the best. Whether the additional cost covers the occasional removal of broken bolts is problematical. While the tests were not altogether satisfactory, on account of variations, they indicate pretty clearly that drilling adds life, punching is better than no hole, and upsetting is bad. It is questionable if the all-threaded bolt is any better than the one stripped between sheets. However, it is equally as good and there is reason to justify such a belief. When preparing bolts in large quantities, it is impossible to strip the threads right up to the sheets, as it would require an almost infinite number of lengths. As almost all bolts break close to the outside sheet, and even a thread inside sometimes, the stripping of thread in the center leaves the bolt no more flexible or no weaker at the stripped portion than elsewhere, consequently there seems little to be gained by this practice.

Riveting of heads, in my estimation, is the largest factor. Two similar bolts headed by the same man vary in the testing machine in proportion to the amount of abuse they received in being headed. The reason assigned for the United States Government method giving superior results, seems to be the reverse of the statement you make. In testing the hand-headed bolts, those that were driven hardest broke first. The riveting crystallizing the harder irons and making it more dense and a tighter fit in the sheets, the result being that,

when firmly held by the entire thickness of the sheet, the stress was concentrated at the inner side of the sheet. When loosely driven, so as to allow movement in the plate, it was found almost impossible to break them. The United States Government method of heading confines the injury to the metal, to that part outside of the sheet, or at least prevents it from extending through the sheet, as in hand riveting. Not being held so rigidly in the sheet, the stress due to vibration is distributed somewhat, and this, with the greater flexibility from the same source, greatly prolongs the life of the bolts.

The strains on a staybolt that are most destructive are those due to the difference in expansion and contraction of the inner and outer sheets. From the nature of these strains, a staybolt is similar to a cantilever, having a concentrated load applied repeatedly at the end, removed, and the direction of application reversed. On staybolts of uniform section the maximum stress is located, therefore, at the outer edge of support—in this case the outer shell. Consequently, the less rigid the support, due either to thin sheets, heading as above, or both, the greater the life, as these conditions may allow the entire movement to take place without inducing a fibre stress equal to the elastic limit of the material in the staybolt. Theoretically, it would seem that the use of thin outer sheets is justified. Practical considerations, however, indicate the questionability of this. With thin outer sheets, which may have plenty of strength, there is, on the other hand, very little margin left for corrosion and kindred evils that determine the life of the boiler. For this reason it seems preferable to renew a few bolts occasionally and add to the life of the sheet by making it a little heavier than considerations affecting the staybolts only demand. Unless it is necessary to sacrifice strength and life to weight, ½ inch would appear to be the minimum thickness for the outer sheet, and, on the other hand, it is not advisable to increase this very much, as, starting with ½ inch as a minimum, we may, along with the life of the sheet, consider the effect of increased thickness on the staybolts. As regards the fire sheet, the average practice seems to be to make the side sheets 5/16 inch thick and the crown sheet ⅜ inch thick, up to and including 180 pounds pressure. Above 180 pounds the side sheets are also made ⅜ inch thick.

Further results of investigation are confirmed by the article in question, as regards piling. The enclosed tracing shows the piling of several irons tested. A, B, C and E showed little variation as the result of changing direction of vibration; while D, F, G and H were very strong with the piling and weak against it. As they are no stronger than in the weakest direction, they are inferior to the former sections.

That the best iron should be used regardless of first cost is indisputable, but that the best iron does cost the most is another story.

Extremely hard refined irons do not appear to give as good results as softer irons. When removing bolts of hard, fine iron, I have seen one blow cause the head to fly off and strike the wall. The fracture had the fine crystalline appearance of tool steel. The hard irons—and the amount of hardness depends on the amount of refinement, largely—seem to crystallize in heading, and the results of this injury extend much farther than with softer irons. The effect of heading, as regards the fit in the sheet, seems to show that in soft irons it is local and does not extend through the sheet, leaving them more flexible. It appears, then, that the ideal iron is one which, from the method of piling, stands an equal number of vibrations in all directions, and is soft enough to prevent crystallization and rigid fit in the sheets due to the heading.

South Easton, Pa.,
Dec. 9, 1899.

F. F. GAINES,
Mechanical Engineer,
Lehigh Valley R. R.

HIGH SPEEDS OF THE NEW LAKE SHORE PASSENGER LOCOMOTIVES.

Satisfactory running is reported by the Brooks Locomotive Works for the 10-wheel passenger locomotives for the Lake Shore & Michigan Southern, illustrated in our November issue. These engines were designed for hauling heavy trains at high speeds, the chief object being not so much for excessively fast running as for reserve power to handle unusually heavy trains at the highest schedule speeds. The beginning has been made, as is shown by the record of the fast mail train between Buffalo and Cleveland, November 22, 1899.

This train, No. 3, was made up of engine 601, one of the class illustrated in our November issue, four postal cars, two sleepers, one combination car and one coach, or eight cars in all, the weight of which is estimated at 300 tons, exclusive of the engine. The table gives the stations, the time and the distances. It should be noted that the time between stations does not give the seconds. This, in short distances, would influence the speeds in miles per hour materially, and the figures of significance are the times for the long distances. The times between West Seneca tower and Collinwood, taken with the arrivals and departures at Dunkirk, Erie and Ashtabula, give a fair idea of the run. The time from West Seneca to Collinwood is mentioned specially because the runs from Buffalo to West Seneca and from Collinwood to Cleveland are slow on account of the yards between these points. The speed between West Seneca and Collinwood, deducting stops, is 61.17 miles per hour, and this tells the whole story. The speed, including stops, was 56.13 miles per hour, and the average speed for the entire run of 181.92 miles was 52.98 miles per hour. The distance from Dunkirk to Cleveland, 143 miles, was made in 144 minutes. There are three stops for water in this run, also two crossing stops, making five stops in all, which occupied an aggregate of 16 minutes.

This train is scheduled to leave Buffalo at 6.25 P. M. (central time) and to reach Cleveland at 10.50 P. M. On this occasion it was 59 minutes late in leaving Buffalo and yet arrived in Cleveland on the schedule. It would be interesting to know the boiler pressures during this remarkable run, but we are informed that the limit of power was not reached, which is equivalent to saying that the boiler capacity was not severely taxed. During the entire run a strong side wind was blowing, making the work more difficult.

The Brooks Locomotive Works furnished eleven of these magnificent engines, and our readers have already been informed as to their details. The record of the run is appended.

Stations.	Time Depart. P. M.	Time Arrive.	Distance.
Buffalo	7.24	....	....
Buffalo Creek	7.31	....	....
West Seneca Tower	7.35	....	4.36
Athol Springs	7.39	....	4.87
Lake View	7.44	....	5.18
Angola	7.51	....	7.05
Farnham	7.55	....	4.11
Silver Creek	7.59	....	5.82
Dunkirk	8.15	8.10	8.84
VanBuren	8.21	....	4.00
Brocton Junction	8.26	....	4.79
Westfield	8.34	....	8.05
Ripley	8.42	....	7.88
North East	8.50	....	7.66
Harbor Creek	8.56	....	6.51
Erie	9.07	9.03	7.45
Dock. Junction	9.13	....	....
Swanville	9.19	....	8.24
Girard	9.25	....	7.08
Springfield	9.29	....	4.63
Conneaut	9.35	....	7.64
Tower No. 2	9.40	....	....
Kingsville	9.43	....	7.41
Ashtabula	9.53	9.48	5.82
Coal Chutes	9.57	....	....
Geneva	10.03	....	9.34
Madison	10.08	....	5.42
Perry	10.13	....	4.99
Painesville	10.18	....	5.73
Mentor	10.23	....	6.16
Willoughby	10.27	....	4.34
Wickliffe	10.31	....	4.33
Nottingham	10.35	....	4.57
Collinwood	10.37	....	2.04
Glenville	10.39	....	1.95
Cleveland	10.50	....	5.33

	Miles per hour.
West Seneca to Collinwood, including stops	56.13
West Seneca to Collinwood, not including stops	61.17
Erie to Collinwood, not including stops	61.95
Erie to Collinwood, including stops	58.51
Erie to Cleveland, including stops	55.37
Erie to Cleveland, not including stops	58.19
Speed, including stop at Dunkirk	53.18
Speed, West Seneca to Erie, including stop at Dunkirk	56.14
Speed, West Seneca to Erie, not including stop at Erie	59.64
Average speed to Erie, not including stop at Dunkirk	56.04
Average speed in 181.92 miles	52.98

THE DEVELOPMENT OF THE STEEL CAR.

The large number of steel cars now in service and the crowded condition of the plant of the Pressed Steel Car Company are evidences of a sudden and remarkable revolution in car construction which may be profitably reviewed.

There are now in service in this country nearly 20,000 steel cars, and the capacity of the works of the Pressed Steel Car Company is now 75 cars of 40 to 50 tons capacity per day, and this will soon be increased to 100 cars per day. With the orders now on hand, and with continued prosperity for the railroads, it is probable that during the year 1900 30,000 steel cars will be built, and at the end of that year there will be 50,000 steel cars of large capacity in service on American railroads.

It is instructive to notice how a question which has occupied the serious attention of the Master Car Builders' Association for a number of years and finally given up as a hopeless task will settle itself by commercial and economic pressure and by the effort of individual genius outside the Association. In June, 1896, a committee of that Association made a report on steel cars which dealt with the necessity for standard sizes for steel cars, not only in general dimensions, but in the size of the rolled sections, it being taken for granted that the future car would be made of rolled beams, channels and angles. The economical side of the question was also discussed and the important fact that steel cars would have a larger ratio of carrying capacity to light weight than wooden ones was pointed out. It was shown that 50 per cent. of the cost of freight car repairs was for wheels, axles, bearings, brake shoes and other similar parts which will wear out as rapidly under the most perfect steel car as under the present design of wooden car, and that the steel car body must produce increased earnings and cost enough less for repairs to pay for the interest and depreciation of its extra first cost.

The 1896 Master Car Builders' Association report included a design for a steel hopper car made for the Carnegie Steel Company. The capacity being 100,000 pounds and light weight 39,950 pounds, a sample car of this kind was exhibited at the 1896 convention, and this was, doubtless, the real beginning of the 50-ton hopper car industry, and the prototype of the pressed steel hopper car which was designed by the Schoen Company, and appeared at the convention in 1897. The action of the association on the 1896 report was the appointment of a committee of five to present individual designs. The report of this committee in June, 1897, again emphasized the importance of standard general dimensions, and stated that the great majority of motive power officers were not prepared to consider a car of greater capacity than 30 tons for general interchange service. Three members of the committee presented plans for steel box and flat cars, and exhibited three sample cars, with steel under-frames. The Schoen Pressed Steel Company exhibited two pressed steel 50-ton hopper cars. The committee was discharged and a new one appointed to criticise the plans already submitted, and here the work of the Master Car Builders' Association on this subject virtually closed. In 1898 the new committee reported that it did not have sufficient information in detail to make exact and complete calculations of the strength of the cars, designed by members of the previous committee. Acting under the impression that its principal business was to recommend a standard steel car, the 1898 committee reported that it was impossible to design a car which would meet with universal favor and the limited experience with steel cars was a sufficient reason for not selecting a design at that time. The report was accompanied by plans of the Schoen 50-ton hopper car. The committee was discharged and at the convention of 1899 no report on steel cars was made and no committee appointed.

In 1897 the Schoen Company received their first large order for steel cars, and built 600 pressed steel cars of the double-hopper gondola type, 50-tons capacity, for the Pittsburg, Bessemer & Lake Erie R. R. In that year they also built several hundred somewhat similar cars for the Penna. R. R. In 1898 the Schoen Company and the Fox Company were combined, forming the Pressed Steel Car Company. The business has rapidly grown to its present enormous proportions, which will soon have a capacity of 100 large steel cars per day.

The cars for eastern roads have been largely 50-ton coal cars with inclined self-dumping floors, the anthracite coal trade having developed coal wharves suitable for hopper cars. In the west, however, the preference seems to be for a gondola car with a horizontal floor, flat drop bottom doors, and a capacity of 40 tons. Quite a number of these fine-looking cars are now running on western roads. Several years ago the Fox Company built a few coal cars with steel under-frames and a wooden box, and this idea is again coming to the front, and a large order has been given for cars of this type. In the Master Car Builders' Association reports on the subject (1896 and 1897) illustrations were given of box cars with a steel under-frame and a wooden box, the capacity being 60,000 pounds. A number of roads now find it desirable to build box cars having a capacity of 40 tons, and this large capacity immediately suggests the advantage of a steel under-frame. We understand that the construction of a large number of 40-ton box cars with steel under-frames and wooden superstructure is now under consideration. The necessity for cars of large capacity for general interchange service, in which box cars make their largest mileage, has not been felt heretofore, and they are not likely to show such superior economy as the large capacity coal cars in local and special service. But the mixture of heavily loaded steel cars with wooden box cars in through freight trains is causing such frequent failures of wooden cars, that a new and strong argument for steel under-frames for box cars is rapidly making itself felt. Large numbers of wooden cars are being sent to the shops for repairs, and numerous wrecks are caused by the failure of old wooden cars, when forming parts of trains of big steel cars. The weak cars are either pulled apart or crushed by the application of the air brake. It may be fortunate that the life of the old cars is thus shortened, and it is an advantage to have them out of the way. The draft-rigging on old wooden cars is so poor that trains are broken in two, and it is not possible with such weak links in the chain to utilize the full tractive power of large locomotives. This evil exists to such an extent that it has been necessary to issue general orders on several large roads to reduce the train loads, and the old wooden car is therefore at present the regulating element in determining the maximum train-load. Strange to say, it is not the power of the engine or the car capacity nor the car lading (all of which have been pushed almost to the extreme limit) which are to be principally considered in tonnage rating, but the very uncertain and troublesome feature of a poor draft-rigging on an old wooden car. This also, we believe, will in the future be one of the principal reasons for building steel under-frames for all classes of freight cars.

The steel car in service is not entirely free from troublesome features. Car inspectors say that when the couplers fail on these cars they are difficult to replace without sending them to the shops, and it is frequently necessary to chain steel cars together, and this is always a dangerous expedient. Another trouble with steel cars arises from the drop door fastening working loose and permitting the load to dump out on the track. Recently several steel hopper cars dropped their doors and lading while in motion, and after the train was stopped hydraulic jacks were necessary to force the doors, with their load, back into position.

The shop repairs of steel cars will soon require a new kind of a car shop, more like a boiler or bridge shop, with metal working tools, such as punches, shears and riveters. It will also require a new kind of repair man, who instead of being a carpenter must be a metal worker. The shops, tools, and men will soon adjust themselves to the new order of things and provision for steel car repairs must be made a prominent feature of new car shops.

Consolidation Freight Locomotive—Illinois Central R. R.

WM. RENSHAW, *Superintendent of Motive Power.* ROGERS LOCOMOTIVE WORKS, *Builders.*

HEAVY CONSOLIDATION LOCOMOTIVE.

Illinois Central Railroad.

Built by the Rogers Locomotive Company.

Another heavy locomotive has been added to the remarkable list for the past year. This one is for regular road service on the Illinois Central. It was completed last month and is reported to be doing satisfactory work. This engine is lighter than that of the 12-wheel type recently furnished the same road by the Brooks Locomotive Works, and illustrated in our issue of October, 1899, page 316. That only one of each of these heavy types was built seems to indicate hesitation to go too fast into heavy engines.

The design illustrated is among the heaviest of the consolidation type. There are two heavier, however, viz., the Pittsburg, Union Railway Consolidation (issue of November, 1898, page 365), and the Baldwin Vauclain Compounds for the Lehigh Valley (issue of December, 1898, page 395).

This engine will run on one of the divisions south of the Ohio River and was intended to be powerful enough to haul trains of 2,000 tons over 38-ft. grades. The tractive power at 85 per cent. of boiler pressure is very nearly 50,000 pounds. The heating surface is not large for such a total weight, in fact, the heating surface is but 286 square feet more than that of the new 10-wheel passenger locomotives of the "Lake Shore," and it is 146 square feet less than that of the new Delaware & Hudson consolidation engines described in our December, 1899, issue. It is perhaps not perfectly fair to compare locomotives on a basis of power by stating their relative heating surfaces and weights on driving wheels, but as the hauling power is determined by the weight upon drivers and as the sustained boiler power depends very largely upon the heating surface, the following figures will be interesting, and they are fair when comparing the consolidation engines with each other.

	Union Ry. Consol. Pittsburg.	I. C. R.R. Consol, Rogers.	I. C. R.R. 12-wheel. Brooks.	D. & H. Co. Consol. Schenectady.	L. V. Consol. Baldwin	L. S. & M. S. 10-wheel Passenger Brooks.
Weight on drivers in lbs.	208,000	198.000	193,200	157,500	202,232	133,000
Total heating surface....	3,322	3,203	3,500	3,349	4,103	2,917
Lbs. on drivers per sq. ft. divided by heating surface	63	61.2	55	47	49	45.5

The Lehigh Valley and the Delaware & Hudson engines have wide fireboxes and are out of the narrow firebox class, but they are included in order to show the results of efforts to make the weights count in the boiler capacity. It is exceedingly interesting to see the standing of the new Brooks fast passenger locomotives for the Lake Shore in this respect. The question here indicated is, what is the value of the ratio between boiler power and the limiting weight? Different designers certainly have very different ideas and this seems to be a most excellent argument for an elaborate test to show whether it is worth while to get this ratio down on heavy engines.

The boiler is very large, the diameter being 80 inches at the front course. The firebox is unusually large, the grate being 11 feet long and the grate area 38.5 square feet. This is believed to be the largest grate ever used for a narrow firebox engine. The firebox is above the frames, and the mud ring is wider than the frames, giving a width of 42 inches to the grate. The boiler is of the Belpaire type with two rows of sling-stays in front. The steam pressure is 210 pounds per square inch. The center of the boiler is 9 feet 2 inches above the rails, the top of the stack is15 feet and the crown sheet is 10 feet 6 inches above the top of the rail at the flue sheet. With such a large and heavy boiler we should expect the center of gravity of the locomotive to be very high, but Mr. Reuben Wells, Superintendent of the building company, states that it was located by experiment at a point 50½ inches above the rails. We shall print an account of how this was found.

We illustrate a few of the details of this engine, but there are interesting features in those that are omitted. The cylinders are 23 by 30 inches. The pistons are of cast steel and only 7/16 inch thick in the plates. The piston rods are extended, the forward portion passing through a sleeve 8 inches long, but without a stuffing box. The crosshead looks small for such surroundings, but it has a bearing of 8 by 24 inches and is amply strong. The top and bottom slippers are removable, each in one piece. The cast-steel driving boxes, shown in Fig. 7, are also strong and light, the driving journals are 9 by 12 inches, which would necessitate an exceedingly heavy box if made of iron. It has dove-tailed grooves for babbitt strips to bear against the hubs of the driving wheels, which are also of cast steel. In an engine of this size it is possible to obtain a thrust of as much as 42 tons alternating from one side to the other of the engine and changing in direction at every stroke. That is what a 23-inch cylinder gives with a steam pressure of 200 pounds per square inch, which will probably be imposed upon these pistons at slow speeds. This has been provided for by a steel plate casting bolted to the back of the cylinder saddle and very securely bolted to the frames. This casting is nearly five

feet long and is intended to aid in holding the enormous stresses referred to and to take some of the twisting strains.

Figure 2 shows the general arrangement of the engine, the draft appliances and the driving spring rigging. Figure 4 shows the arrangement of the valve connection to enable it to pass the second driving axle. The yoke is of cast steel and its weight is carried by the link, D, of Figure 5, which is supported to a cross-brace of the frame by the bracket, F. In Figure 4 the back end of the yoke is seen to be double. The pin, H, passes through both portions and also through the link block. The link is provided for in tne space, O, of this engraving. This permits it to come very close to the axle. The yoke is closed at the bottom of the thimble, G, through which a bolt passes as indicated.

The link and hanger are shown in Figure 6. The hanger is double with a connection across the parts, the link has a face

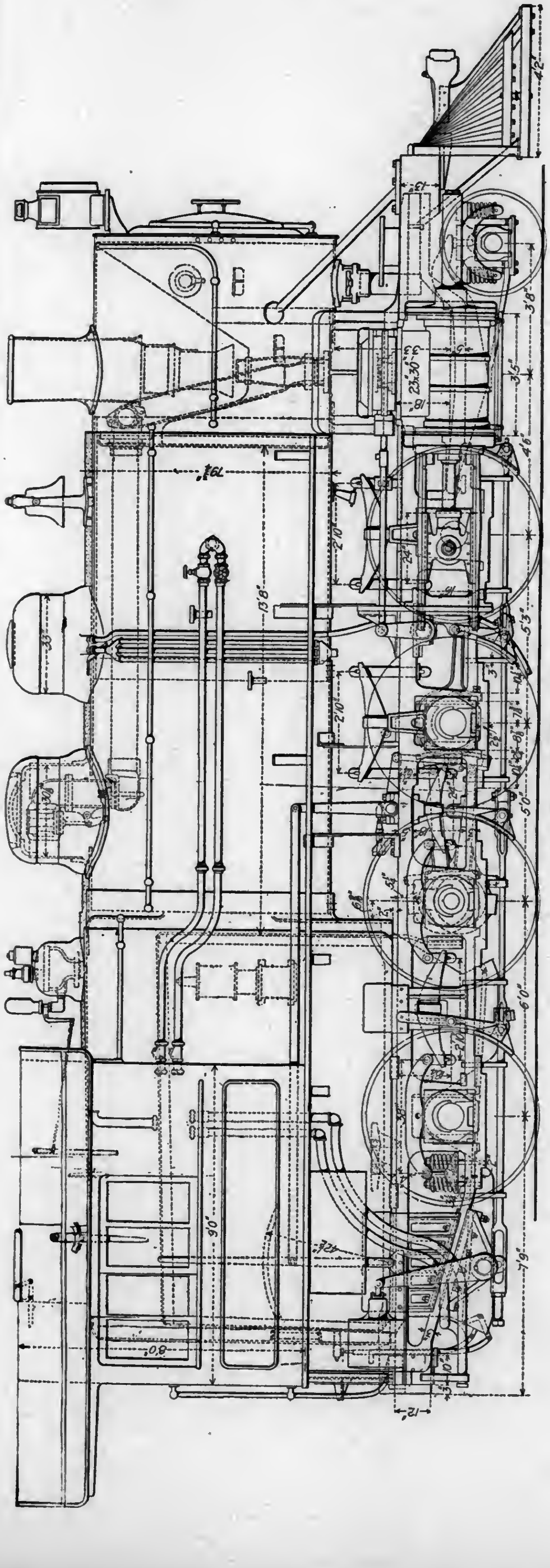
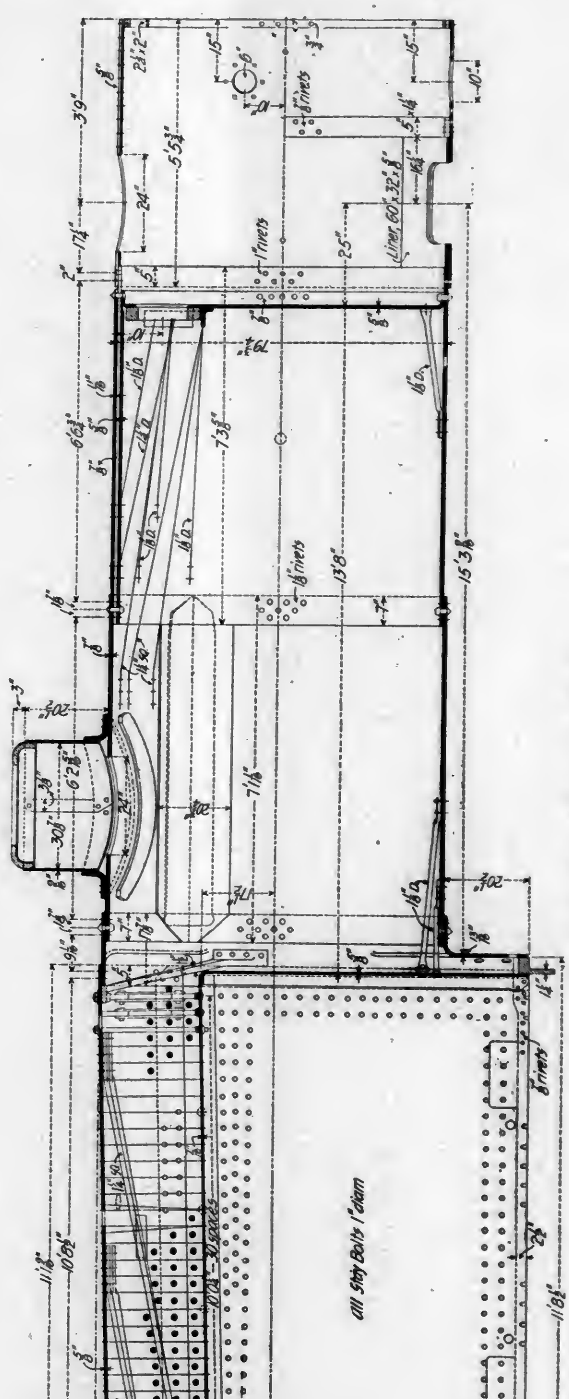


Fig. 2.—Side Elevation.



Longitudinal Section of Boiler.

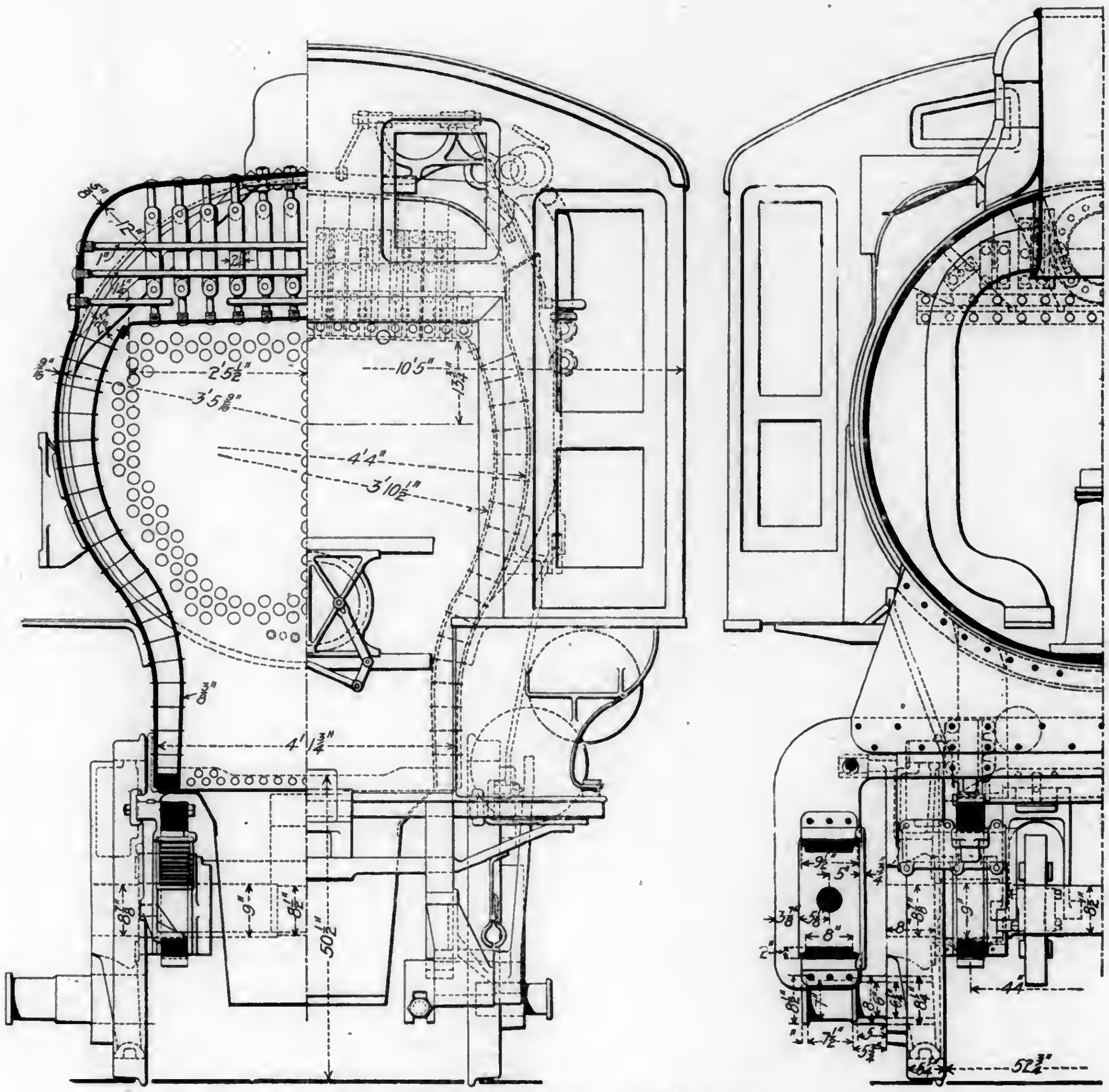


Fig. 3.—Half Sections and End Elevations.

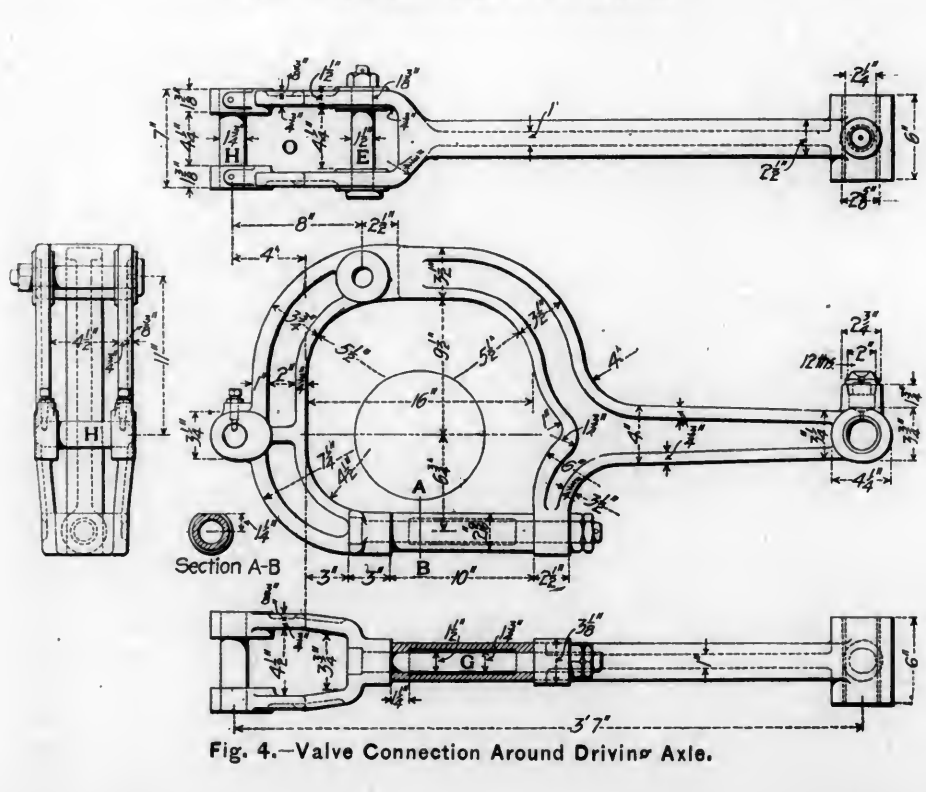


Fig. 4.—Valve Connection Around Driving Axle.

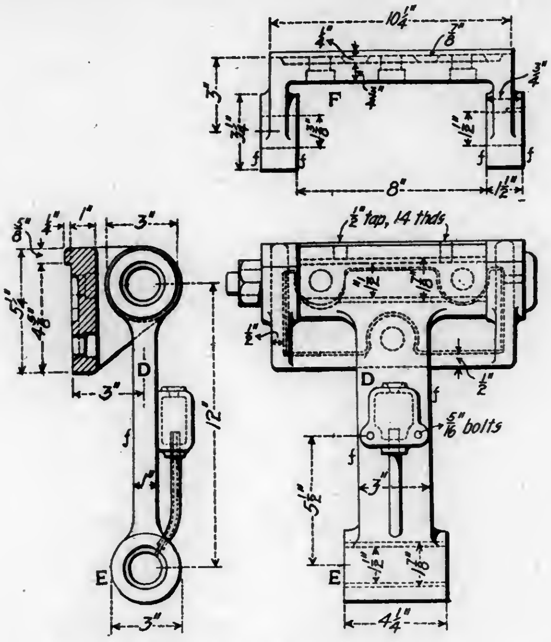


Fig. 5.—Support for Valve Connection.

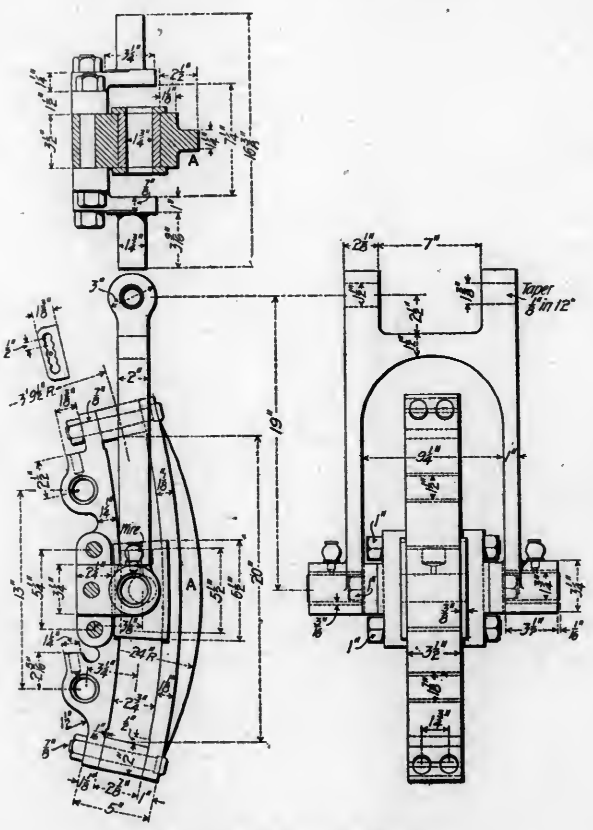


Fig. 6.—Link and Link Hanger.

of 3½ inches. The saddle is in two parts and is secured to the back of the link. The link is stiffened by the rib, A, which is a good plan for working valves as large as these.

The following table gives the chief characteristics of the engine:

Cylinders	23 by 30 in.
Total weight in working order	216,000 lbs.
Weight on drivers	196,000 lbs.
Weight on truck	20,000 lbs
Driving wheels, diameter	57-in.
Driving wheel centers	50-in.
Driving journals	9 by 12 in.
Driving wheel base	16 ft. 3 in.
Total wheel base	24 ft. 5 in.
Boiler type	Belpaire
Boiler pressure	210 lbs.
Boiler diameter in front	80 in.
Boiler, height of center above rail	9 ft. 2 in.
Heating surface, firebox	252 sq. ft.
Heating surface, tubes	2,951 sq. ft.
Heating surface, total	3,203 sq. ft.
Grate area	33.5 sq. ft.
Firebox, inside	132 by 42 in.
Firebox, height front	78 in.
Firebox, height back	75 in.
Tubes, number	417
Tubes, diameter	2 in.
Tubes, length	13 ft. 8 in.
Thickness of sheets in boiler	⅞ and ⅝ in.
Thickness of crown sheet	7/16 in.
Thickness of firebox, sides and back	⅜ in.
Thickness of firebox tube sheet	⅝ in.
Slide valves	Allen-American
Slide valves, travel of	6 in.
Steam ports	1 5/16 by 23 in.
Exhaust ports	3¾ by 23 in.
Bridges, width of	⅝ in.
Piston rods	Extended
Piston rods, material	Nickel steel
Crank pins, material	Coffin process
Pistons	Cast steel
Guides, width	9½ in.
Guides, material	Wrought iron
Smoke stacks	Cast iron
Cab	Steel
Truck wheels	McKee-Fuller
Truck wheels, diameter	33 in.
Truck axles	Iron
Truck axle journals	6 by 10 in.
Tender capacity, water	5,000 gals.
Tender capacity, coal	10 tons
Tender trucks	Fox
Tender wheels	McKee-Fuller
Tender wheels, diameter	36 in.
Tires	Krupp
Boiler covering	Franklin Mfg. Co.
Brake	Westinghouse

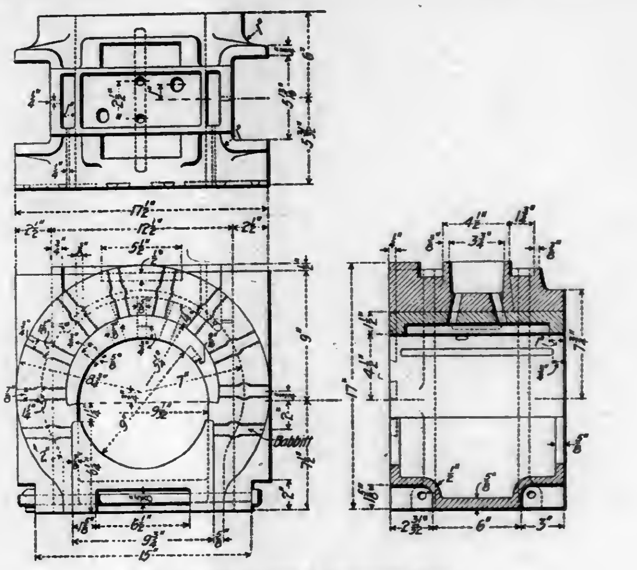


Fig. 7.—Cast Steel Driving Box.

The size of the electric motors in a system of electric subdivision of power has an important effect upon the ultimate economy of the plant; this has been shown by Mr. George Gibbs in this country and by Mr. John S. Raworth in England, before the Manchester Association of Engineers. Mr. Raworth says that the whole question is bound up in the cost and efficiencies of the various sizes of motors. For instance, it may be perfectly easy to show that 40 horse power may be economically transmitted to a distance and reproduced by a motor of 90 per cent. efficiency. But if the same power is required to be much subdivided and reproduced by motors having an aggregate cost of three times as much as that of the single motor and having an efficiency of no more than 75 per cent., then the balance may be on the wrong side. For instance, if a motor of 20 horsepower costs $750, 20 motors of one horsepower each would cost $2,400, to which extra switches and fittings should be added.

A new use for the stereopticon method of instructing and examining railroad employees has been found. Mr. W. J. Murphy, originator of this idea, has sent us a copy of a letter received from Prof. F. P. Anderson of the mechanical engineering department of the State College of Kentucky, at Lexington, stating that this method will be used in instructing the students of that college in the meaning of railroad signals.

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MASTER MECHANICS WANTED.

Why is it that four important railroads, and perhaps more, are having difficulty in securing satisfactory Master Mechanics? We have at the present time four such applications on file in this office, one of the positions having been vacant for several months. The salaries offered are good, the openings are excellent and the prospects for advancement encouraging. In one of these cases $3,000 a year will be paid to the right man.

Is the fault with the roads, in neglecting to educate young men for promotion? Is it with the technical schools in any way? Is it with the young men themselves? It is clear that something is wrong, perhaps with one and perhaps with all of these. The questions are offered to those whose success and usefulness are closely concerned in answering them.

The compound locomotive has had no more earnest and competent supporter than Mr. F. W. Webb, of the London and Northwestern. Prof. Goss, in his letter from the Crewe works, in this issue, reminds us that Mr. Webb began his experiments twenty-one years ago and has labored in developing the compound locomotive entirely uninfluenced by any lack of sympathy which he has encountered. It is possible that time will show him to have been far in the lead of English practice in this particular, because, now that the limits of clearances are becoming serious in that country, it will probably be necessary to turn to the compound for the desired increase in power.

In the standardization of locomotive parts Prof. Goss shows Mr. Webb to have been very far-sighted. Seven hundred engines with the same cylinders and boilers represent what he has done in this direction in the matter of general design. He goes even beyond this in the smaller details; for example, there are but two eccentrics on the whole road having 2,800 locomotives. To many this will seem like overdoing the idea. It is not overdone, however, until the standardizing begins to obstruct progress. Probably under Mr. Webb's conditions this has not occurred. There is more danger of too little than too much standardizing in this country.

That the staybolt question is one of the most important of the day in locomotive practice is proved by the statements made in this issue by Mr. F. W. Johnstone, Superintendent of Motive Power of the Mexican Central Railroad. Safety is, of course, first in importance, but the expense of renewal is of itself sufficient to enlist the attention of everyone interested in locomotive maintenance. Frequent inspection is necessary to safety, and when engines must be held at least once in 30 days for this purpose the cost of this item is considerable. The expense of renewing broken bolts is not in itself a very large item, but when it becomes necessary to take down parts to get at the firebox the cost becomes enormous and is probably much greater than is generally believed. Mr. Johnstone's statement that it sometimes costs $10 to renew a single staybolt is alarming and is a satisfactory reason for taking advantage of every opportunity to reduce and overcome the trouble. If Mr. Johnstone's new form of staybolt will accomplish this, and it seems promising, the additional cost of the application should be and probably will be cheerfully borne.

The correspondence from railroad men called out by our discussion of Staybolt Progress in the December issue indicates that the staybolt difficulty is causing no little concern and the contemplation of the effects of the increased steam pressures of recent years does not tend to afford relief to the anxiety. Staybolt material has been sent us by prominent motive power men who desired to know whether it is "the best that is to be had," and whether it is "safe material." This may be taken as a satisfactory indication that slightly increasing expense will be gladly assumed for the protection that is so greatly desired.

Mr. F. F. Gaines, Mechanical Engineer of the Lehigh Valley, has valuable suggestions to offer on this subject, and while his comments may seem somewhat radical to those who have seen only what may be termed average practice, we believe that he is correct and we are glad to print his views on points raised in the article referred to. The burden of proof is on the other side of this question, at least for the present.

Laboratory tests of locomotive boilers do not reproduce road conditions in regard to vibration and oscillation of the engine, and by some this is considered as a serious disadvantage because of its influence in reducing the power of the boiler when on the testing plant. The communication by Prof. Smart, in another column of this issue, is based upon experience at Purdue, and it is interesting to know his opinion that this influence is overestimated. What our correspondent says about the maximum power of boilers is important in its bearing upon boiler design as well as being appropriate in this connection. The real power of a boiler is not that which it may develop for a short time, but for sustained service. It is

not that which may be developed in the first few hours of a run, but the response which may be counted upon at any time when needed, that determines the power of a boiler and the capacity of the locomotive. The grates and firebox are closely concerned in this question.

PAYING FOR WORK DONE.

Is the Piece-Work System Defective?

Piece-work has made considerable headway in this country, and it has accomplished a great deal in the development of industrial enterprises. It is an economic advance which pays men according to their worth and encourages them by bringing immediate results for increased efforts. It tends to increase wages, under certain conditions to promote contentment, to increase output and to save in many ways by making the life of the workmen more promising, and he, instead of counting the hours, reckons the amount of work accomplished. He urges the foreman to keep up with the shop and the foremen does not need to urge the shop. The system does all this and all goes well until a certain point is reached, when a defect appears which those who know most about the subject consider a fatal one. The defect of the day system is that improvements favor the employer only, in piece-work they favor the workman except as the increased output is an advantage to the employer. The defect of the piece-work system with a fixed rate per piece is that it makes no provision for the effects of the inevitable decrease in cost of production brought about by the various improvements which are from time to time introduced. The workman obtains the entire advantage except the one mentioned. The result is one of two things: Either progress in improvement will stop at the point where the men begin to fear a cut in their prices, or the employer, who can never be happy when men are getting the advantage over him, will make a cut in the schedules and sacrifice the confidence of the men. If prices have been carefully fixed at the start this may require a long time, but if there is progress the time will come when the issue must be faced. The employer needs to have a direct interest in the further exertions of the workmen just as much as the men need to have an interest in producing short cuts and suggesting improvements. A piece-work system cannot be considered satisfactory unless it is clearly to the interests of the employer to have the men earn as much as they can.

In a paper by Mr. R. T. Shea, read in November, 1899, before the Western Railway Club, the generally understood advantages of piece-work were outlined and in the discussion Mr. G. R. Henderson, Assistant Superintendent of Motive Power of the Chicago & Northwestern, touched upon what is now being urged as the remedy for this defect in piece-work systems when he suggested that any increase in the product of a day's work (on the day-pay basis) should be divided between the employer and the workman. Mr. F. A. Halsey's plan (American Machinist, March 9, 1899, page 180), is as follows:

"Taking round numbers for convenience, suppose a workman to be paid $3.00 per day of 10 hours and to produce one piece of a certain kind per day. The wages cost of the product per piece is obviously, $3.00. Now, under the premium system the proprietor says to the workman. 'If you will reduce the time on that piece, I will pay you a premium of ten cents for each hour, by which you reduce it.' If a reduction of one hour is made the first result to the employer is to save the wages of 30 cents for the hour which has been saved, but against this is to be placed the ten cents earned as a premium, leaving a net gain of 20 cents to the employer, and a net increase of earnings of ten cents to the workman. Had the premium offered been 15 cents, the result of an hour's reduction of time would have been to save 15 cents to the employer and to increase the workman's earnings by the same amount."

The premium plan fixes a time for a certain piece of work and pays a premium for every hour saved. In practice it has been found safe to count upon cutting down the time of machine work operations by one-half. The standard time and the premium need to be fixed with great care. The standard time must not be too short or the premium too great. Mr. Halsey's experience has shown it to be satisfactory to the workman if he receives one-third of the amount he saves. This plan has the effect of keeping the foremen up to their best work, and it is found to be a greater test of the management than of the men. This plan means that the larger the workmen's wages in a given time the less is the cost of production and the greater the advantage to the employer. The premium plan is apparently applicable to any processes to which piece-work may be applied.

Men have objected to this system because it was considered as piecework under another name, which shows their opinion of piecework. Some such plan as this administered with fairness seems likely to prove to be what the industrial situation needs. Summed up, this may be stated as follows: Work inevitably cheapens and some sort of a premium plan is the only way to reduce the cost of production without cutting prices.

FIBRE STRESS DUE TO IMPACT.

By Edward Grafstrom.

If a piece of iron is inserted in a testing machine, and the pressure which stretches it is gradually increased, the ratio between the elongation and the force causing it may be represented graphically by a curve, the ordinates of which refer to the elongations and the abscissas to the corresponding forces. Many testing machines are provided with recording apparatus automatically drawing this curve, which is characteristic of the material. If the gradually increased pressure in the machine were substituted by a falling weight impinging upon the lower, free end of a vertically suspended bar, a similar diagram would be obtained. According to the law of kinetic energy the falling weight would not come to a state of rest until the work done by the impact had been absorbed, or, in other words, when the work of the external force balances the internal strains, the velocity of the lower end of the bar becomes equal to zero. When the internal strains equal a static load of the same weight, the lower end of the bar reaches its maximum velocity. From this point the work as well as the velocity decreases, until the latter quantity finally reaches its zero-value, when the bar remains at rest for an instant, after which it begins to contract. It would continue to oscillate in a vertical direction, were not the energy consumed in producing heat, structural changes, etc.

By assuming that the elastic impulse is transplanted with an infinite velocity, so that the deformation of the body is instantaneous throughout its structure, and all parts of the body are set in motion and again come to rest simultaneously, the dynamic principles above referred to may be used for determining the fibre stress in a body under impact, providing that the proportional limit is not exceeded. One of the most convenient formulas for this purpose, which has come under the writer's observation, is the one by Mr. John Davidson, presented in a recent number of the "Technical Journal" of Stockholm, Sweden. The results of this formula have been verified by the testing machine, within the limits prescribed, which puts it beyond speculation, and, as it may be new to many, its development will here be explained.

If a body is acted upon by a static force, and this is increased in a certain proportion, N, the deformation as well as the fiber stress will also be increased in the same proportion. If now a dynamic force producing N times as large deformation is substituted for the static force, the fiber stress it produces is obtained by simply multiplying the static fiber stress by N. In order to determine the dynamic co-efficient, N, the work of the external forces is put equal to the work of resistance of the internal strains, for, as already stated, it is under these conditions that the body attains its greatest deformation.

Returning to the example of the vertical bar with a falling

weight impinging upon its lower, free end, and by plotting the strain curve referred to, as in Fig. 1, with P representing the weight, h the height, and y the elongation, the rectangle, A B C O = Ph, gives the kinetic energy, L, of the weight at the moment of impact. The static deformation work, W, caused by P is equal to the triangle, O F E = ½Py. The sum of the work by the external forces at the maximum deformation is then, A B D G = A B C O + O C D G. The internal stresses are represented by the triangle, O G H. Consequently, A B D G = O G H. According to the definition of N, O G = Ny, and G H = N P. O C D G is therefore the same as N Py, and O G H the same as ½N²Py, also A B D G = Ph + N Py. By insertion the equation Ph + N Py = ½N²Py is obtained, from which the value of N is found thus:

$$N = 1 + \sqrt{1 + \frac{L}{W}}.$$

If the external forces are suddenly applied, but without attaining any velocity, L becomes = O, and consequently N = 2,

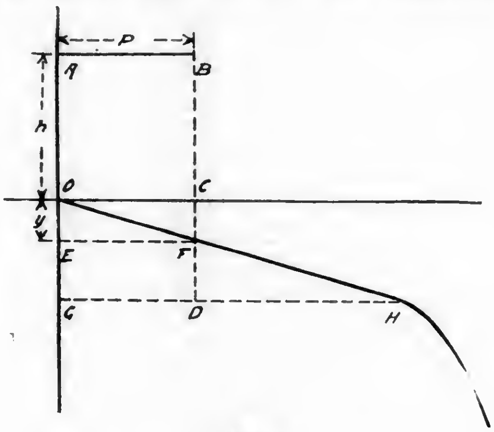


Fig. 1.

or, in other words, the fiber stress becomes twice as large as under the same static load.

The practical application of Mr. Davidson's formula is of wide range, and as it may enable the designer to determine the detail dimensions of machines or structures exposed to dynamic influences more accurately than by experience or from similar analogical conditions, it may be interesting to illustrate its usefulness in the following examples:

Example 1. A vertically suspended iron bar of a length, l = 100 inches, and with a sectional area, A = 1 square inch, is struck at its lower, free end by weight, P = 450 pounds, falling from a height, h = 1 inch. The support as well as the weight are considered inelastic. Find the maximum fiber stress, S.

Here, W = ½Py, if y represents the maximum elongation; y is also equal to Pl divided by AE, where E stands for the modulus of elasticity. W is therefore = P²l, divided by 2A E. If this and the value of L = Ph are inserted in the formula, it will appear thus:

$$N = 1 + \sqrt{1 + \frac{2\,A\,E\,h}{P\,l}}.$$

Assuming E as 27,000,000, we get:

$$N = 1 + \sqrt{1 + \frac{2\,.\,1\,.\,27{,}000{,}000\,.\,1}{450\,.\,100}} = 35.66.$$

The static fiber stress being 450 pounds per square inch, 450 multiplied by 35.66 gives the dynamic fiber stress, S = 16,047 pounds.

Example 2. A beam fixed at one end is acted upon by a weight, P, falling from a height, h (see Fig. 2).

The work of deformation for a strip of the length, x, and the area, q, at the distance, z, from the neutral axis (see Fig. 3), is, as before, and using the same letters:

$$W = \frac{(q\,S)^2\,x}{2q\,E}.$$

If S′ is the stress at the distance z, and S″, the stress in the uppermost element, then S′ : S″ = z : e. Now, S″ = M : I, M and I relating to the distances x and z, respectively, and $I = \int z^2 q$. From this the value of W is obtained:

$$W = \frac{1}{2\,E}\int\frac{M^2\,x}{I}$$

and when the cross section of the beam is constant:

$$W = \frac{1}{2\,E\,I}\int M^2\,x.$$

From this equation the value of N is obtained, according to Mr. Davidson's formula:

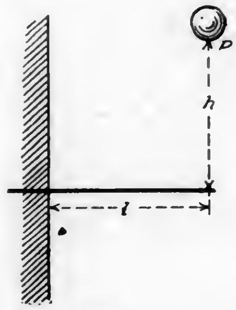
$$N = 1 + \sqrt{1 + \frac{2\,E\,I\,L}{\int M^2\,x}}.$$

Inserting the values

$$\int M^2\,x = \int P^2\,x\,Q^2 = \tfrac{1}{3}\,P^2\,l^3$$

we get

$$N = 1 + \sqrt{1 + \frac{6\,E\,I\,h}{P\,l^3}}.$$



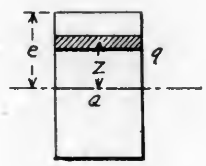


Fig. 2. Fig. 3.

Example 3. From what height may the tup in a drop-testing machine fall upon a standard M. C. B. 4¼x8-inch steel axle, without straining the axle beyond the proportionate limit (Fig. 4)?

Inserting the numerical values in the formula, we get

$$N = 1 + \sqrt{1 + \frac{6\,E\,.\,16\quad O.\,0491\,.\,(4\tfrac{5}{8})^4\,.\,h}{1640\,.\,36^3}}$$

which gives

$$N = 1 + \sqrt{1 + \frac{E\,h}{35478}}.$$

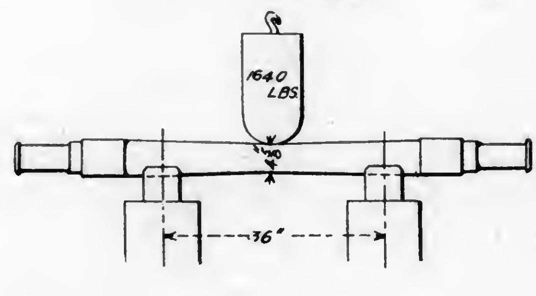


Fig. 4.

The fiber stress under a static load of 1,640 pounds is

$$F = \frac{1640\,.\,4\tfrac{5}{8}\,.\,36}{4\,.\,2\,.\,0.\,0491\,.\,(4\tfrac{5}{8})^4} = 1.520\ \text{lbs.}$$

According to Prof. W. K. Hatt's paper at the Pittsburg meeting of the Association for Testing Materials, the proportionate limit of steel bars under the conditions at hand may be taken as 33,900 pounds, and the modulus of elasticity as 29,386,000. Using these figures, we would have 33,900 = F N, or

$$33{,}900 = 1{,}520\left(1 + \sqrt{1 + \frac{29{,}386{,}000\ h}{35{,}478}}\right)$$

which gives h = O, 54 inches.

EDUCATION OF MACHINISTS, FOREMEN AND MECHANICAL ENGINEERS.

The paper on this subject read before the American Society of Mechanical Engineers in December, by M. P. Higgins, was characterized by Captain Robert W. Hunt of Chicago as the most important paper ever brought before the society.

It is a severe arraignment of the existing order in education for technical mechanical pursuits and is worthy of most attentive consideration from those whose needs this journal is intended to reach.

Many excellent schools are preparing young men to be mechanical engineers, but few are educating machinists and foremen. The need is for these men. One hundred of them are wanted for every one mechanical engineer, and the author's object was to describe a well-considered plan to provide for this vital necessity. His fundamental idea is to base the education on the machinist's trade and without any intention of interfering with the high-grade technical institutions he would make it possible for a boy to become a competent mechanic and at the same time obtain a good school education. Everyone knows the situation with regard to apprenticeship. Mr. Higgins seeks to answer the question: "How can we give our boys a chance to learn a trade without being deprived of a good common school education and at the same time secure a foundation upon which to build a higher education if capacity and circumstances permit?"

He does not propose a new plan to educate the mechanical engineer. He desires to give the machinist's trade and the common education to those who need it, and to do this in a commercially conducted shop which is manufacturing for the open market and is combined with a good school system.

This is a good start for all of the three grades mentioned in the title of the paper. The man who is first a good machinist, trained in a shop which is obliged to frame its conduct on commercial principles, and is qualified to be a foreman, has the best sort of foundation for success as a superintendent and as a mechanical engineer. It is insisted by all that the mechanical engineer requires shop experience and more than he can get in the usual technical school. In view of this we are of the opinion that the high grade technical schools can profitably consider an application of this idea to themselves. There is no doubt that those who start with Mr. Higgins' plan and afterward qualify for mechanical engineering work will be in far greater demand than those who start with the education first and attempt to get the shop experience afterward. To attempt to give even a synopsis of the paper is out of the question here, but we shall try to state its underlying principles.

Mr. Higgins gives the chief features of what he terms the "Half Time School," as follows:

First.—A school which shall include a first class commercially successful and productive machine shop, which is a department co-ordinate in importance, influence and educational value with the academic department.

Second.—A school in which the pupils are to have instruction and practice in this shop during half the working hours in five days of each week for a period of four years.

Third.—Instruction in the public schools during a portion of the other half of the time, equivalent to a high school course, restricted, abridged and improved to meet the needs of these pupils.

Fourth.—Special care and method of selection of pupils who have finished the grammar school course and who have special aptness for mechanical work.

Fifth.—Management under a corporation whose trustees shall be practical business men.

The idea will be new to many, but it is shown to be practicable by the entire success of the Washburn Shops of the Polytechnic Institute of Worcester, Mass., of which the author of the paper has been Superintendent for 27 years. These shops have carried out the idea fully and successfully. This result is in a large measure due to the ability and earnestness of the Superintendent, and it will be difficult to secure such men. They are to be had, however, and it is difficult to understand why the work of teaching should be intrusted to any but those who are best able to do it. This plan means a higher grade of instructors, because they must be men who can hold their own in the competition of commercial affairs. The present college professor has the highest ideals, but it is most difficult for him to keep in touch with commercial conditions unless, as in such a scheme as this, he must do so or fail.

The author says that at a recent meeting of managers it was stated that 200 young men suitable for foremen for foundries could be placed at once. Nothing is more difficult than to find good men for these positions. If, however, a president, a treasurer, salesman or mechanical engineer is wanted, there is no difficulty. The man who is able to manage the practical details of the shop and not only do good work but also do it cheaper than his competitor, is relatively very rare.

The proportion of boys completing courses in the public schools is small, and it is believed that if a good living was assured upon the completion of a four years' course, more would endeavor to take it. The technical schools do not reach this class; first, because the requirements are high and are tending even higher, and second, because these schools are for the scientist rather than the mechanic. This type of school is beyond the reach of boys who are to become workmen and also beyond the reach of many who would make engineers. Mr. Higgins says:

"This school is aimed to fit each boy for the successive grades of mechanics from the machinist up, so that at any time he will be fitted to take up his work outside as a well-trained mechanic in the grade which he has completed, and be prepared to enter the training of the next grade. In other words, the object of the school is to produce many well-trained and educated machinists, and from these machinists some foremen, from the foremen a few superintendents, and finally an occasional engineer.

"'Many are called, but few are chosen.' We need not grieve at the very few chosen, because but few are required. But few professional engineers can be employed, provided the great body of working mechanics are effectively educated to think clearly, keenly and quickly.

"We may hope for much from a thousand educated, thinking, expert American machinists who have the skill, education and an exact knowledge of the shops. Is not the production of one hundred well-educated workmen a more certain undertaking than the production of one genius?

"The hindrance to the best results in engineering schools, which has come from the imperfect and unfair method of selection in making up or enlisting its classes, has already been mentioned. Under the present system it is a boy's business to spend several years of cramming for examinations after he decides upon going to a polytechnic school or college. His whole aim and the aim of his teacher is to prepare for the examinations. The fitting school develops an astonishing ability to pass examinations which are not a true or adequate test of a boy's fitness to make a mechanic or a mechanical engineer. Therefore the entering class of the polytechnic institute consists of a body of experts at examinations, while the boys all through the country who ought to be trained for manufacturing and mechanical industry are overlooked and passed by."

The idea about the shop is to secure as far as possible the conditions which will permit of competing with the best equipped commercial shops in the country, and the organization may be almost the same as if the school element were entirely left out. The Worcester success shows that there are no insurmountable difficulties in the selection of the kind of machines to build or in the manufacture and sale, provided that the management is what it should be. The capacity of the shop should be such that, if desirable, at any time, one-third or one-half as many hired men may be employed as the total number of students. This is one of the fundamental ideas whereby the instruction is surrounded with the real shop atmosphere.

In the light of the long experience of the originator in this field, we are inclined to give weight to the following state-

ment: "We can confidently assure a more thorough expert knowledge of the machinist's trade and a more practical skill in its various departments than is generally secured by any apprenticeship in this country or Europe." The same applies to this also: "These pupils will receive as a part of their shop practice a much larger amount of time in lectures and instruction upon the technical part of the machinist's business than is given in the technical school."

This is a period of transition in educational matters and methods in all lines. It takes time to bring radical changes about, but with the wide and deep interest manifested in this subject in many directions, the necessary improvements can not fail to begin at once to make advances. For a well-considered presentation of a plan drawn up by a man with lofty and sensible views of technical education, this paper is commended to our readers, who are becoming more and more dependent upon properly trained assistants. They should at once take steps to secure copies of the paper from the Secretary of the American Society of Mechanical Engineers. We have, in our editorial rooms, a limited number of copies which will be placed at the disposal of those who ask for them.

CORRESPONDENCE.

THE EFFECT OF THE LOADING OF LOCOMOTIVES ON FUEL ECONOMY.

Editor American Engineer and Railroad Journal:

I have been much interested in the description of locomotive tests on the Norfolk & Western in the December number of the "American Engineer," and greatly pleased to find that the theoretical solution (referred to on page 392, and which was worked up by the undersigned, when connected with the Norfolk & Western) has been confirmed by the practical tests. It was here found that an increase of 20 per cent. in coal burned per ton-mile was caused by an increase in the load hauled of 10 per cent. (page 394). By referring now to page 206 of the June, 1899, issue of the "American Engineer," a load of 700 tons at 10 miles an hour on a 1 per cent. grade should require 47 pounds coal per 100 ton-miles, and a train of 770 tons, or 10 per cent. increase, 53 pounds, or 13 per cent. increase, in fuel consumption. The test was made on a grade of about 1.2 per cent., and this increase in consumption is probably quite logical for these conditions. On a level, an increase from 2,000 to 2,400 tons did not show an increased consumption of coal per 100 ton-miles, and this also corresponds with the diagram on page 206. It must be borne in mind that too great a reduction in the weight of the train will also be accompanied by an increase in the consumption of fuel, as we should pass the economical point of cut-off. In a combination of grades and levels the latter will often be so great a proportion of the total haul that an uneconomical loading for the grade will give an economical train on the level; for instance, a grade 10 miles long, requiring a cut-off of 90 per cent. for a train-load that required only 25 or 30 per cent. cut-off on a level 100 or more miles in length, would evidently not be sufficient to overcome the economical effect of the level haul. The whole subject is one of great interest to motive power officers at this time, and any reports which throw light upon it are heartily welcome.

G. R. HENDERSON,
Assistant Superintendent Motive Power,
Chicago & Northwestern Ry.

Chicago, Ill.,
Dec. 11, 1899.

THE POWER OF LOCOMOTIVE BOILERS ON STATIONARY TESTING PLANTS.

Editor American Engineer and Railroad Journal:

I have read with interest the paper on "Road Tests of Locomotives" presented at the September meeting of the New York Railway Club, by R. P. C. Sanderson, together with the discussion which followed. I find both paper and discussion full of suggestion and information.

There were some statements, however, in the discussion which, it seems to me, call for further remark. The gist of these statements was that, owing to the peculiar conditions under which locomotive boilers operate on the road, it was possible to secure nearly one horse-power per square foot of heating surface; that this condition was probably due to the motion of the boiler, which had a tendency to keep the water solid upon the tubes and thereby prevent priming. Reference was made to laboratory tests of locomotive boilers in which a boiler capable of developing 1,500 horse-power could only be made to show 750 horse-power when tested on a stationary plant. The conclusion drawn from this was that it was impossible on a stationary plant to get as much out of a locomotive boiler as could be obtained on the road.

To those familiar with the operation of stationary testing plants, it is constantly shown that a locomotive boiler may at times and for considerable periods supply steam sufficient to generate at the engine, horse-powers approaching in figures the number of square feet of heating surface contained in the boiler. This, however, does not represent the capacity of the boiler, but is an abnormal condition which cannot be maintained continuously. The true measure of the capacity of the boiler is what it will do for several hours on a stretch, ending in practically the same condition as it started. For this reason, any deductions as to the maximum capacity which may be maintained by a boiler on the road are apt to be very misleading. If the boiler output is figured from indicator cards, those cards may not have represented the average horse-power developed at the cylinder; if it is figured from draw-bar pull, the draw-bar pull may have been an unusual one and not representing average conditions. The very nature of road service, as it affects the boiler, the fact that for certain periods large powers are developed and then time is given to recover and recharge, so to speak, gives opportunity to greatly overestimate the maximum output which a given boiler continuously delivers. For these reasons, the statement made, that it was possible to obtain nearly one horse-power per square foot of heating surface is, it seems to me, open to serious question.

Referring now to the second statement, namely, that locomotive boilers in stationary service or on the testing plant, could not be made to develop the same capacity of which they were capable in road service, I would say, first, that if what has just been said be true, there may have been an error in determining the maximum capacity of which the boiler was capable on the road, and which was said to have been greater than the performance of the same boiler on the testing plant. Second, that it is possible that the stationary test was not designed to force the boiler to its utmost capacity, and, third, that tests have been made on a stationary plant which would seem to show that the capacity of the boiler was not affected by the running of the engine, but was merely a function of the draft.

The movements of a boiler on the road may be classified under three general heads: First, the forward motion along the rails; second, the more or less irregular swaying of the boiler up and down and from side to side; and, third, the continuous and severe vibration of comparatively high frequency and small amplitude. On the testing plant the first of these movements is, of course, absent; the second one is only present occasionally and in a small degree; the third class is, however, present and in about the same degree as in ordinary road service. This has been proven in many ways. It would seem to the writer that if the motions of a boiler have any effect to increase the production of dry steam, that the third, or vibratory movements, would be the most important, in that they would have a tendency to jar the particles of steam away from the heating surface as fast as formed. As has been said, this vibratory condition is to a very large extent present on the testing plant. Tests have been made in which the valves were blocked away from the seat and the steam allowed to blow through the exhaust, which have shown that with a given draft the evaporation of water per square foot of heating surface was practically the same as if the engine were running and the same amount of draft had been produced in the usual way. This would seem to point to the conclusion that the motions of the boiler in service do not have the effect of increasing its output to the extent that would be inferred from the discussion quoted.

R. A. SMART,
Associate Professor of Experimental Engineering.

Purdue University,
Lafayette, Ind.,
Nov. 25, 1899.

RAIL WASHER TESTS ON THE BURLINGTON.

Editor American Engineer and Railroad Journal:

The article on page 380 of the December issue, on the value of the rail washer to remove the sand from the rails as carried out on the Chicago, Burlington & Quincy, is a most interesting one, but I believe the diagrams and tables do not bring out all of the advantages of the device, because the comparisons were made in such a way as to include the grade resistance in the train resistance. On a grade of 1.3 per cent. the grade resistance is 26 pounds per ton, and grade resistance is like death—it is sure. Furthermore, the tonnage must be wrong in the article; the figures evidently should be 396.7 and 302.8 tons instead of 3,967 and 3,028 tons, the decimals having been apparently misplaced. These figures attracted my attention at once because, of course, an engine with a drawbar effort of 12,000 pounds could not pull a 3,967-ton train on a 1.3 per cent. grade.

What I want to call your attention to particularly is that you do not properly bring out the results of the tests by plotting the total resistance. The grade resistance being 26 pounds per ton, is 10,314 pounds in the case of the full train. Then, why not simply plot the train resistance alone? This would show what an enormous effect the sand has. This can easily be done by drawing a horizontal line on the diagram of the full train record at the point of 10,314 pounds drawbar pull. This

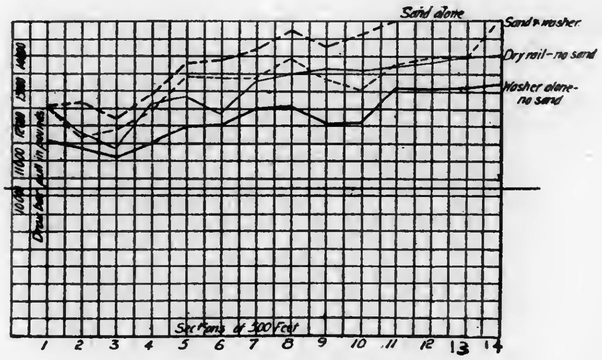


Diagram of Resistances.

introduces somewhat of a difficulty, however. Subtracting 10,314 from the average drawbar pulls given in the table gives results for train resistance as follows:

	Pull in lbs.	Lbs. per ton.	Rating.
Sand alone	3,122	7.85	100 per cent.
Sand and washer	2,554	6.42	82 per cent.
Dry rail	2,197	5.53	70.5 per cent.
Washer alone	1,516	3.82	48.7 per cent.

I consider that the figures for the washer alone look rather small, and you will notice that all of the figures at section 9 on the diagram are low, but they vary together. I should suppose that the train accelerated between sections 8 and 9, thus reducing the drawbar pull; but it is equally fair to all to deduct the grade resistance. The mere fact that the quantities are larger and that the discrepancies appear more noticeably in the total amounts is of no more value than adding an arbitrary 50,000 pounds would be. Put upon the basis of train resistance only, it shows what a valuable appliance the rail washer is.

In confirmation of this, I had a little experience with a very large freight engine on a Western road in testing it on a grade of 1.55 per cent. It was found necessary to use a great deal of sand, which increased the train resistance considerably. I have not the figures at hand, but, if I am not mistaken, the load was increased from 31 to 34 cars by the use of the washer. In this case the water was taken from the tender tank and I do not see why it should be taken from the boiler. The additional heat in this hot water will surely not be enough to avoid freezing in winter, because it is not great as compared with that given out in freezing, and the tank water washed the rails effectively, at least, we thought so.

Chicago, Ill., H. H. VAUGHAN.
Dec. 12, 1899.

[We have reproduced the diagram of the tests with the new base line, as suggested by our correspondent, because the point raised as to the effect of the washer on a level track appears to be a good one. It is understood that in the case of the Burlington the washer is used only on grades, but, to get at the maximum effect of the device, the grade resistance should be eliminated.—Editor.]

LOCOMOTIVE EDUCATION.

Editor American Engineer and Railroad Journal:

Mr. E. L. Coster's communication on locomotive instruction in technical schoosl, page 379 of the December issue, was of special interest to me. This revival of interest in technical schools affects all engineering courses as well as that pertaining to the locomotive, and if there is need for such a revision in locomotive engineering courses, it is even more necessary that improvement take place first in the mechanical engineering course, which forms the basis of locomotive engineering.

Our technical schools are beginning to realize the necessity of up-to-date ideas and commercial methods of conducting the work of the shops and laboratories. During the past ten years they have not kept abreast with commercial improvements. It is for this reason more than any other that such interest is being taken in improving these conditions. We must bear in mind that it is not an easy matter for the professors and instructors of the ordinary technical school to keep up with the best and most modern work and do it by the most improved methods. And probably the only way to bring about such results would be to put the work as made in the shops and laboratories out on the open market. This privilege should be allowed the colleges of the country as well as the penitentiaries. And when tnis can be done the trouble which railroads experience in getting the right kind of machinists and foremen will be overcome.

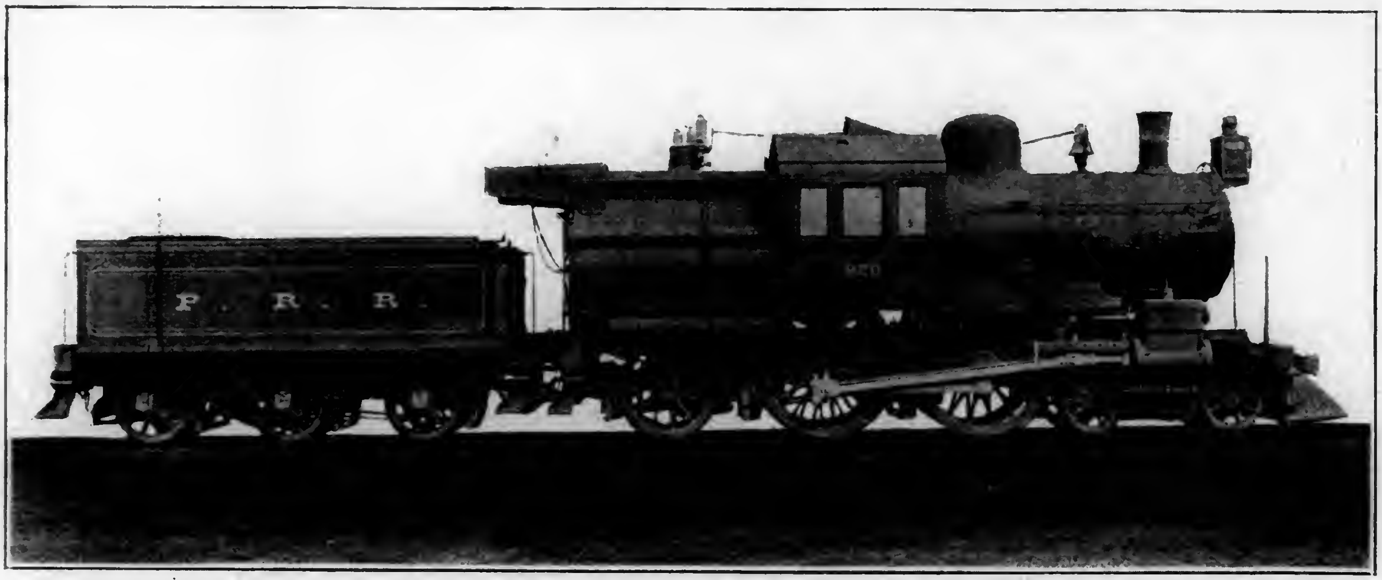
I have at hand a letter from one of the most wideawake technical institutions in the country. And in view of the fact that the school has met in the past with such success in the courses taught, the head of the school is engaged in further revising the courses so as to fit the graduates to meet more nearly the demands of the engineering world. Blanks are being sent to the graduates of the college who are in positions to give, from their three to four years of practical experience, the information desired. These blanks contain six questions which are to be answered and returned with any additional suggestions which may be offered. The questions asked are as follows.

1. Name the course and class in which you graduated.
2. Name the subjects in your course which you think have proved of most practical benefit to you.
3. To which studies do you think we should give more time than we now allow? Name in order of importance—most important first.
4. Name the subjects of least value to you, in order of importance—least valuable first.
5. Which subjects in the course would you retain, but give less time to them?
6. What subjects would you omit altogether from the course?

These questions may prove suggestive to other technical institutions. CHIEF DRAFTSMAN.

Chicago, Ill.,
Dec. 15, 1899.

A bright idea in piece-work was devised some time ago by Mr. E. E. Davis, Assistant Superintendent of Motive Power of the New York Central, while he held a similar position on the Philadelphia & Reading. The men who used material were put on piece-work and those who prepared the material were working on the day-rate system. The result was that the piece-workers kept hurrying the day-workers to keep up the supply of material so that their wages would not be made to suffer for lack of work. This is an excellent illustration of the operation of the piece-rate system and it was also a bit of good management.



Fast Passenger Locomotive—Pennsylvania Railroad—Class E1.

ATLANTIC TYPE FAST PASSENGER LOCOMOTIVES.

Pennsylvania Railroad.

Class E 1.

The magnificent new Class E 1 Atlantic type engines of the Pennsylvania which were completed last summer have been making excellent records in the development of great power at high speeds. Mr. Theo. N. Ely, Chief of Motive Power, has kindly supplied us with a photograph and diagram of one of them and particulars concerning the fast runs made on the West Jersey & Seashore Division. These engines were built at the Juniata shops and are of the best possible workmanship. They are handsome in appearance and the design in every particular reflects the characteristic and broad-minded intelligence of the officers of the mechanical department.

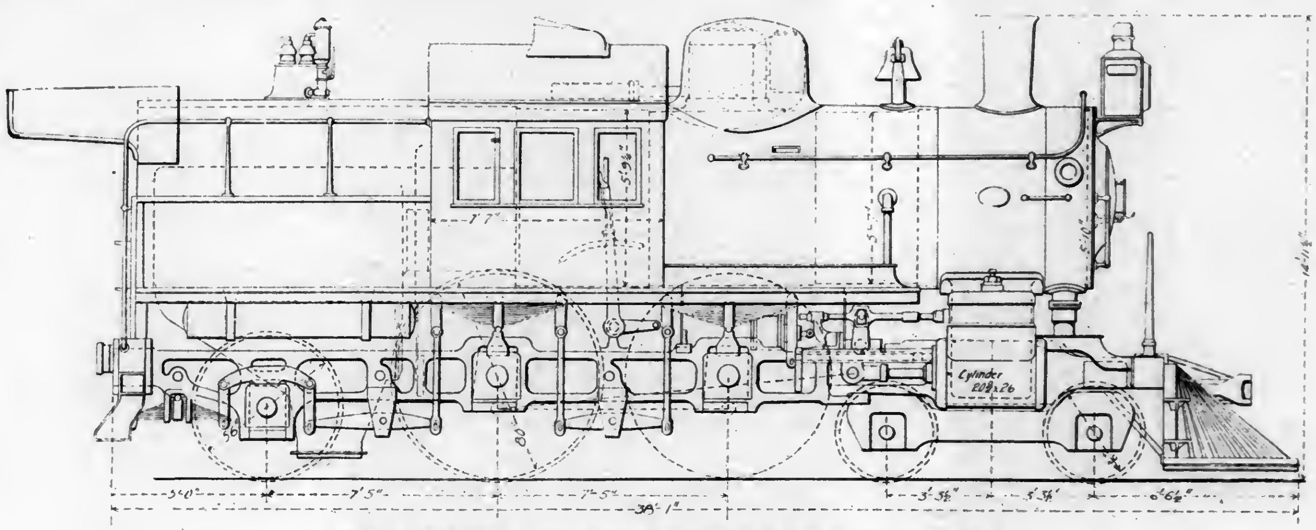
The principal dimensions of the engines are as follows:

Number of pairs of driving wheels	2
Diameter of driving wheels	80 in.
Size of driving axle journals	9¼ in. and 8½ in. by 13 in.
Length of driving wheel base	7 ft. 5 in.
Total wheel base of engine	26 ft. 6½ in.
Total wheel base of engine and tender	50 ft. 5 in.
Number of wheels in engine truck	4
Diameter of wheels in engine truck	36 in.
Size of engine truck axle journals	5½ by 10 in.
Spread of cylinders	85½ in.
Size of cylinders	20½ in. by 26 in.
Steam ports	1½ in. by 20 in.
Exhaust ports	3 in. by 20 in.
Travel of valve	7 in.
Lap of valve	1½ in.
Type of boiler	Belpaire wide firebox
Minimum internal diameter of boiler	65⅞ in.
Number of tubes	353
Outside diameter of tubes	1¾ in.
Length of tubes between tube sheets	156 in.
Fire area through tubes, square feet	4.33
Size of firebox, inside	104 in. by 96 in.
Fire grate area, square feet	69.23
External heating surface of tubes, square feet	2,102.4
Heating surface of firebox, square feet	218.0
Total heating surface of boiler, square feet	2,320.4
Steam pressure per square inch, pounds	185
Number of wheels under tender	6
Diameter of wheels under tender	42 in.
Size of tender truck axle journals	5 in. by 9 in.
Weight on truck in working order	38,125 lbs.
Weight on first pair of drivers	50,250 lbs.
Weight on second pair of drivers	51,300 lbs.
Weight on trailing wheels	33,775 lbs.
Weight on engine in working order	173,450 lbs.
Tractive power per pound of m. e. p.	149.0
Tractive power with m. e. p. equal to 4/5 boiler pressure	22,052

The boiler has a 42-inch combustion chamber, a wide firebox in which the Belpaire form of staying is retained, a total heating surface of 2,320 square feet, of which 2,102 are in the flues and 218 in the firebox. The boiler is said to weigh, empty, 37,494 pounds. The grate area is 69 square feet and unusually large for this road. The fuel is anthracite coal. The smokestack is short, but it has an extension down into the smokebox to a point about 17 inches from the top of the exhaust nozzle. It has been found advantageous to use this arrangement of the exhaust appliances on this road instead of the plan recommended by the Master Mechanics' Association. The ash pan and dampers have had careful attention; the ash pan is made tight and the dampers are of cast-iron and close fitting. The location of the sandbox within the dome casing, in front of the steam dome, is novel. The casing is elongated for this purpose and it looks well. The dome appears to be large, but not too large for such a boiler.

In many respects as regards details, this design resembles the Class H 5 and H 6 freight engines illustrated in our issue of June, 1899. The front sections of the frames are of slab form, with the same excellent arrangement of cylinders cast separate from the saddle and with the same carefully planned fastenings between the cylinders and saddle and the frames. The frames are of cast-steel and are very strong. The rear portions are 4 inches thick and are reinforced by more material at the jaws. There is but one steam pipe and that makes an S-bend in its upper portion and becomes straight before passing through the diaphragm. It enters the center of the saddle casting in the rear of the exhaust pipe, and at the cylinders on each side, where there is too little space for a single pipe of sufficient size, it branches into two pipes for a short distance. The exhaust connections from the cylinders pass through the frames. This arrangement of steam and exhaust passages is remarkably direct and it should be easy to maintain in good order.

The 80-inch driving wheels are handsome and light steel castings, the truck wheels are 36 inches in diameter, and the trailing wheels 56 inches; yet they do not look large because of the good proportions of the engine. A central cab never looked so well before. These engines have very light pistons, light cross-heads, and the Vogt guide, which has a bearing surface 10 inches wide for the top of the cross-head, and it is enclosed for protection against cinders and dust. The washer of the cross-head pin is in one piece with an oil cup. The main rods are unusually long, and, like the side rods, of fluted section. The back end of the main rod is solid with a block held in place by a half round gib and key, the latter being secured by a clamp and two set screws. The valve rod is supported at the back end and the valve motion is similar to that of the freight engines referred to. The setting of the valves has been studied most carefully and this accounts for the power at high speeds. The lead is made 3/16 inch in the tenth notch, and at that point gives a cut-off of 12 inches. The greatest lead is ¼ inch, in the fourteenth notch, which gives a cut-off of a little less than 5 inches. The valves have a



Fast Passenger Locomotive—Pennsylvania Railroad-Class E1.

travel of 7 inches, 1½ inches outside lap and 5/32 inch inside clearance on each side. This is unusually large and is doubtless very useful in getting rid of the exhaust steam. Among the minor details of the running gear the hanging of the brake shoes at the rear of the driving wheels should be mentioned. The brake cylinders are placed in front of the forward pedestal jaws of the front driving wheels. The truck wheels are also braked.

The truck has a new, and, we believe, a very important feature. The pivot is 9½ inches back of the center of the wheel base and yet the load is carried centrally between the axles and is equally distributed between them. The purpose of this is to lengthen the lever arm of the forward wheels and to reduce the impact of the loading and the consequent wear of the leading wheel flanges. The wheel base of the trucks is 6 feet 7 inches. The truck has a steel center casting to which side frames are bolted. These are spaced 27 inches apart, and to their outside faces the pedestals, in the form of brackets, are bolted. The load is transmitted to the boxes by double equalizers, whose ends are united so that they bear directly upon the centers of the boxes.

The tender has a capacity of 4,000 gallons and is carried on three axles, the rear two being equalized. The tender journals are 5 by 9 inches. The six-wheel type was decided upon because it gives a good distribution of the load and does not shake itself to pieces. The coal is carried on a sloping deck extending entirely across the tender, the front portion of which is level and elevated about 18 inches above the deck of the tender. The tank is very strongly braced to hold the coal when the water is low. The photograph shows the rivet heads whereby the position of this coal deck may be seen. Water scoops are fitted to these engines and they are very satisfactory. The scoop is balanced against the thrust of the water, no portion of it is allowed to touch the sides of the trough, and with it 3,500 gallons have been taken in 10 seconds at a speed of 68 miles per hour.

Mr. Ely states that these engines have done very satisfactory work on the seashore line during the past season with fast and heavy trains. These are scheduled at 60 minutes from the Philadelphia side of the Delaware River and 55 minutes from Camden to Atlantic City, or at the rate of 63.6 miles per hour for the distance of 58.3 miles. As 5 minutes is a rather short time for the ferry trip and the transfer of passengers, the actual running time has frequently been less than that. Mr. Ely sends a statement of some of the fast runs and the weights of the trains. These speeds are remarkable, but they are vouched for, and it is evident that these locomotives take place among the fastest in the world. It is probable that they have not been driven to their limit during the first season. The record is printed below exactly as received from Mr. Ely:

Some Exceptional Runs of Regular Trains Hauled by Class E 1 Locomotives from Camden to Atlantic City, Distance, 58.3 Miles, Pennsylvania Railroad Line (W. J. & S. R. R.).

	July 16.	July 20.	July 31.	Sept. 22
Train No.	269	269	269	269
Number of cars	7	8	8	5
Weight of train empty, lbs.	466,100	538,850	526,640	348,950
Number of passengers	317	306	369	152
Running time, minutes	51	53	50½	52
Rate of speed for whole distance	68.6	66.	69.3	67.2

Portions of Above Runs that Were Made at Unusually High Speeds.

Date.	Between.	Distance. Miles.	Time. Min.	Miles per hour. Rate of speed.
July 18	Winslow Junction to Absecon	24.9	18	83.
	Winslow Junction to Drawbridge.	30.6	23	79.8
July 20	Winslow Junction to Drawbridge.	30.6	24	76.5
July 31	Winslow Junction to Drawbridge.	30.6	22½	81.6
	Winslow Junction to Absecon	24.9	18	83.
Sept. 22	Berlin to East Hammonton	16.8	14	72.
	East Hammonton to Absecon	18.7	12	93.5
	Berlin to Pomona	30.	22½	83.1
	Waterford to Pomona	23.7	16½	86.
	Hammonton to Pomona	16.2	10½	92.
	Elwood to Pomona	10.1	6½	93.

Office of the Chief of Motive Power, Broad Street Station, Philadelphia, September 30, 1899.

WHY THE U. S. NAVY ADOPTED WATER-TUBE BOILERS.

The reasons for adopting the water-tube boiler in the U. S. Navy are very admirably set forth in a paper by Admiral Geo. W. Melville before the Society of Naval Architects and Marine Engineers, in which the speaker first expressed his opinion that water-tube boilers are bad in principle, as a failure in a tube is followed by the opening of a fault, while in a fire-tubular boiler the pressure would continue to close a split tube; but on the other hand he considers that the value of their advantages has been sufficiently developed in the last two years to necessitate their use, if we do not wish to be left behind in naval design.

In the fitting out of two ships of identical qualities, one with cylindrical boilers and the other with water-tube boilers, the latter will be somewhat the smaller and handier—will have less draft, and will cost less, and the facility with which water-tube boilers can be removed or completely renewed without disturbing the decks of protected vessels is of itself enough to justify the adoption of water-tube boilers.

The heating surface has gradually been reduced from 3 sq. ft. per horse-power against 2 sq. ft., which is necessary with cylindrical boilers, to 2.4 sq. ft. of heating surface per horse-power. The speaker dwells to some extent on the failures of

the water-tube boiler instead of showing only their good points, for in so doing he gets most information from them.

He also states that so far as he knows, there is not one failure that can properly be said to have occurred purely as a result of being a water-tube boiler. Admiral Melville heartily believes in water-tube boilers as compared with cylindrical boilers for navy use, and gives the following list of advantages: Less weight of water; quicker steamers; quicker response to change in amount of steam required; greater freedom of expansion; higher cruising speed; more perfect circulation; adaptability to high pressures; smaller steam pipes and fittings; greater ease of repair; less danger from explosion; and it is evident that he considers the Babcock & Wilcox type as being specially favorable. He states the disadvantages as follows:

Greater danger from failure of tubes; better feed arrangements necessary; greater skill required in management; units too small; greater grate surface and heating surface required; less reserve in form of water in boiler; large number of parts; tubes difficult of access; large number of joints; more danger of priming.

The opening lecture for the current year in the course of special railway lectures at Purdue University was given on November 28th by President George B. Leighton of the Los Angeles Terminal Railway. President Leighton's subject was "The Work Ahead," and his talk was a brief outline of the opportunities in prospect for those entering railway work. After a short review of the notable events and inventions in railroading in the past, President Leighton discussed the lines along which the coming engineer must work and in which the chances to distinguish himself will be the greatest. The subject is an interesting one and was ably presented.

CAST STEEL BODY BOLSTER.

With Separate Tension Member.

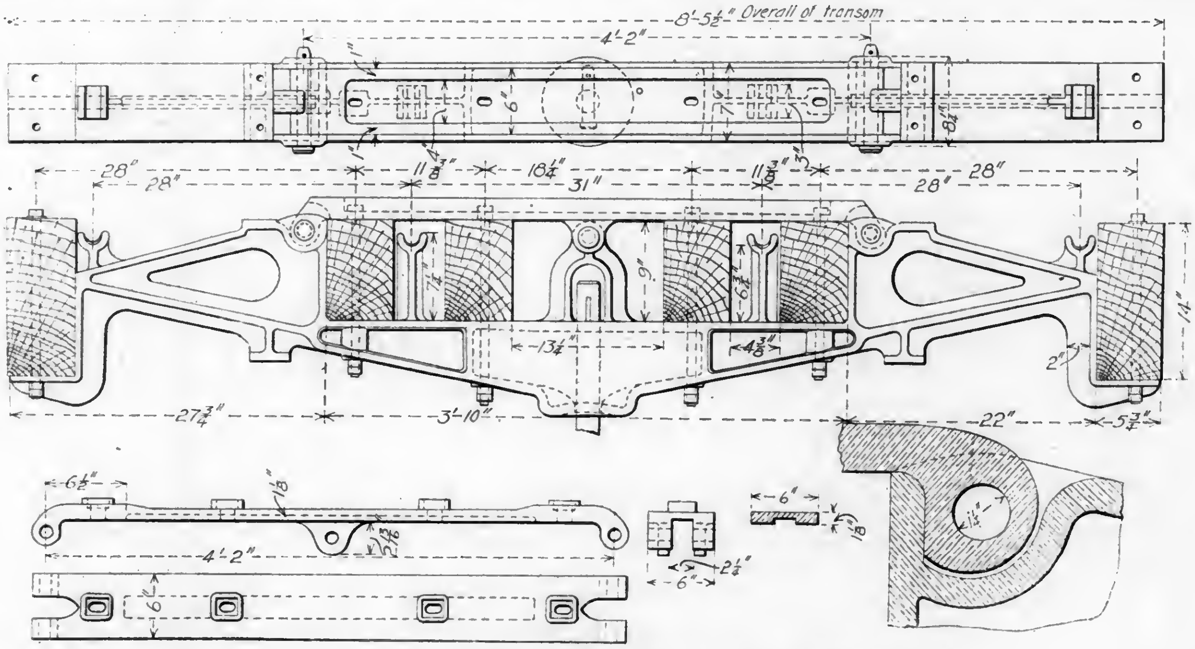
American Steel Foundry Company.

The body bolster illustrated in this engraving was designed by Mr. John Hickey, Superintendent of Motive Power, Rio Grande Western Ry., and is made in soft, open-hearth basic steel by the American Steel Foundry Company of Granite City, Ill. These bolsters are relatively light and very strong. During three years of service they have given satisfaction, and no replacements have been necessary, even on account of wrecks. They are now being applied to several different roads.

We have received drawings of two similar designs, one for cars of 80,000 pounds capacity for coal service on the Rio Grande Western, and the other for 41-foot flat cars of 70,000 pounds capacity for the Northern Pacific. The latter drawing was selected as being well suited to engraving.

This form of bolster may be adapted to various arrangements of sills, and the construction permits of taking the bolster down without removing it from the ends of the sills and taking off the end sill for this purpose. The central portion of the tension member is removable, and by taking out pins at the ends and center the bolster may be lowered and replaced whenever this becomes necessary. The center and intermediate sills rest upon a substantial center casting of box form, upon the ends of which triangular extensions carry the end sills and form the upper side bearings. The truss rod bearings are cast with the bolster and extend up between the center and intermediate sills, with those for the outside near the inner faces of the side sills. A saddle which straddles the center pin forms a connection with the tension member at its center. The form of the chief portion of the bolster needs no special explanation, but it seems desirable to indicate that the number of parts is very small; there are but eight pieces in the entire bolster when the pins and collars are included. The upper center plate is integral with the bolster.

The removable tension piece is in the form of a flat ribbed bar six inches wide, with lugs for pin connections at the center and ends. The end lugs are shouldered by an accurate fit to a distance of 3 feet 11½ inches apart to correspond to the shoulders of the pockets in the main casting in which they



Cast Steel Body Bolster with Separate Tension Member.
American Steel Foundry Co.

An attachment to the nozzles of water cranes for supplying locomotive tenders, to prevent the water from splashing over the tender, has been devised by Mr. Edward Grafstrom, Chief Draughtsman of the Pennsylvania Lines at Columbus, Ohio. As described recently in the "Railroad Gazette," the end of the pipe for a depth of about 5 inches is divided into hexagonal cells by sheet metal partitions. These are sufficient to insure a solid stream from the end of the spout and no canvas or loose funnel appears to be necessary.

The Baldwin Locomotive Works built 104 locomotives in the month of October, 1899, in 26 working days. In November 92 were completed in 25 working days. In 1890 these works built 946 locomotives, on an average of 78 per month, and they were light engines compared with those most commonly ordered now. There are at present 7,250 men employed in this establishment.

rest. The pin holes are drilled and reamed to match closely when the bar is in position and the pins are turned to an easy driving fit. The enlarged sectional view of one of the end lugs of this bar shows its construction and method of bearing.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

Annual Convention.

Papers and Discussions.

The final report of the Committee on the Revision of the Society Code of 1885, relative to a Standard Method of Conducting Steam Boiler Trials, was presented and recommended to the society for use in future investigations. It is a valuable document, worthy of the organization. It is probably the best work of the kind ever done.

Professor Thurston presented an elaborate paper, The Steam Engine at the End of the Nineteenth Century, which contained a record of tests on the Nordberg pumping engine. The paper and discussion made clear the fact that the present tendency was in the direction of improving the steam engine in its use of heat, rather than in the improvements of details and construction. Its present development was in the direction of reducing the wastes, with particular reference to the losses of heat which might be turned to account in heating the feed water.

There was nothing worthy of record from this point until the paper by M. P. Higgins, Education of Machinists, Foremen and Mechanical Engineers, was reached. There were six consecutive papers which were practically set aside by the society as not worth discussing, at least nothing of any importance was offered. Mr. Higgins, however, had the honor of presenting not only the really important paper of the convention, but of introducing one of the most vital subjects ever brought before this organization. The paper is given attention elsewhere in this issue. It was clear in an instant that the subject took a strong hold on the meeting and the readiness to accept and thoughtfully consider the difficult problem is encouraging. The education of the machinists and the foremen of the future was the topic, and that the methods of the present do not reach their cases was very plainly indicated. A synopsis of the paper, which is printed in another column, is commended to those who cannot read it in full.

No discussion was offered to the paper on Experiments of Using Gasoline Gas for Boiler Heating, by Herman Poole. The paper on Colors of Heated Steel Corresponding to Different Degrees of Temperatures, by M. White and F. W. Taylor, was discussed to the point that the temperature corresponding to the colors used to represent different heats are so widely different as given by different authorities that conclusions drawn therefrom are not to be depended upon. The apparatus used for determining these high temperatures seems to have been a cause of this trouble, and the eye of the operator must be largely depended upon until this demand for more accurate measurement shall lead to the use of more accurate pyrometric instruments. The paper on a Broken Fly Wheel and How It Was Repaired, by Jas. McBride, also the paper on Fly Wheel Design, by A. J. Frith, were discussed simultaneously. Valuable suggestions were offered to proportioning part of the rim so that the arms will have the proper tension thrown upon them to make the strains equal to those in the rim section. The method of reinforcing the rims of band fly wheels would obviate such cracking in the arm pads and rims of wheels, as was mentioned in the paper. The Efficiency Test of a 125 Horse Power Gas Engine, was the title of an exceedingly good paper by C. H. Robertson, and while the engine tested, which was a Westinghouse, did not show a remarkably economical performance, the tests as conducted were admirable. The three following important conclusions were reached:

First, That the proportion of gas to air is a very important factor in fuel economy.

Second, That one test at a light and one test at a heavy load would serve to locate the line from which an approximate prediction could be made of the gas consumption under intermediate loads.

Third, That these considerations hold for the fuel consumption per brake horse power and per electrical horse power.

The most interesting, but probably not the most valuable discussion of the session, was that on Strength of Steel Balls. The best methods for testing steel balls were considered. The bearing quality of balls was placed second in importance of testing, the quality of elasticity being first. It is not necessary that we know more about the crushing strength than we already know, for if the balls are picked out according to their elastic qualities there will be no danger of the harder balls doing all the work and in consequence, wearing out the bearing. A simple test for sorting balls as to their elastic qualities is to suspend a bar over a steel plate and drop the balls on the plate. Those jumping above the bar at a certain height are used for one bearing and those getting over the bar at another height are used for another bearing.

The paper by F. C. Wagner, entitled Friction Tests of a Locomotive Slide Valve, did not add anything of value to the information already recorded on the subject and the question was raised in the discussion as to whether the tests represented the conditions of practice.

The Friction of Steam Packings, by C. H. Benjamin, brought out interesting tests, but it was indicated in the discussion that as yet no one had succeeded in making tests in which conditions of practice were sufficiently provided for.

The closing session began with the consideration of the subject of impact tests, introduced by a paper by Mr. W. J. Keep, of Detroit. It was an admirable treatment, but apparently too deep for most of the members, as there was no discussion.

Mr. Francis H. Stillman, of the firm of Watson & Stillman, the well-known manufacturers of hydraulic machinery and apparatus, presented a paper entitled "High Hydrostatic Pressures and Their Application to Compressing Liquids; also, a New Form of Pressure Gauge." This paper contained records of experiments on the enormously high hydraulic pressures of 450,000 pounds per square inch which were conducted at the West Virginia Agricultural Experiment Station by Mr. B. H. Hite. They present the startling but apparently conclusive evidence that liquids are compressible, and, under such pressures as this, to quite a considerable extent. Mr. Stillman says that, under a pressure of 65,000 pounds per square inch, water is compressed over 10 per cent. and alcohol over 15 per cent. The question of the compressibility being due to air in the water was raised in the discussion, but it is doubtful if such a precaution as the removal of the air would be overlooked by a careful experimental expert. To experiment with these high pressures it was necessary to enclose the liquids in closed vessels, on account of the deformation which always takes place in a cylinder under heavy pressures. The suggestion with regard to a new high-pressure gauge was the use of the compressibility of liquids to measure the extremely high pressures. Mr. Stillman's paper will doubtless cause a great deal of comment among physicists as well as engineers.

THE MECHANICAL PLANT OF THE BOSTON SOUTH UNION STATION.

The most valuable engineering paper presented in the recent meeting of the American Society of Mechanical Engineers, held in New York City, was that on "The Mechanical Equipment of the New South Union Station, Boston," by Walter C. Kerr, of the firm of Westinghouse, Church, Kerr & Co. This paper covers 115 pages, with the addition of numerous engraved plates, and thoroughly describes the mechanical plant of the new terminal in Boston, to which we have repeatedly referred. The most interesting feature of this work was the fact that it was intrusted to Mr. Kerr's firm, both in plan and execution. The

work covered was the following: Complete system of electro-pneumatic switches and signals. 2. Comprehensive power-house equipment. 3. Electric wiring and lighting system. 4. Heating and ventilating system for the head house. 5. Passenger and freight elevators in large numbers. 6. Ice manufacturing plant. 7. Refrigeration for restaurant, kitchen and storage. 8. Water filtering and cooling. 9. Car heating equipment for train shed, storage and express yards. 10. Compressed air supply for charging and testing train brakes. 11. Fire protection for buildings and train-shed roof. 12. Disposal of storm water and drainage, all of which is pumped. 13. Frost protection for roof conductors. 14. Steam and hot water supply for head house.

The whole of this extensive work was planned and the drawings prepared in 90 days. This and the satisfactory execution of such a contract could have been handled only in this way, without conflict and trouble as well as additional expense. The very substantial amount of $100,000 was saved to the terminal company by the union of interests in the hands of the Westinghouse concern, and the fact that this company was in position to handle this entire contract and supply nearly all of the equipment is a commentary upon the magnificent proportions of the industries instituted by Mr. George Westinghouse. There was no divided responsibility in this case, and the complication of a blizzard, the worst known in Boston for years, which came upon the very opening of the terminal, did not develop a single failure or weakness in any part of the system. The same firm has a somewhat similar work under way at the Pittsburg & Lake Erie terminal in Pittsburg.

This work was not a power house, or elevators, or electric light plant, or ice-making equipment, but a railroad terminal, and everything had been designed specially with this in view. Everything was on a large scale, but the switch and signal plant was the most extensive work of all. It is stated to be the means of saving $30,600 per year in wages alone over the cost of a mechanically operated plant. A conception of the amount of electrical service rendered is had by noting the fact that there are but three cities in Massachusetts, outside of Boston, in which there are a greater number of municipal arc lights than those used by this terminal. The lamps are on 110-volt circuits, while the motors operate on 220-volt circuits. An ingenious three-wire system was devised whereby the two voltages are secured from the generators at the same time. The lighting was divided into 18 sections each, with its separate switchboard. If the attendant at one of these switchboards desired current, he first communicated by signal wires with the power station, and, when the necessary steam and electric units were ready, he was notified from the power house to throw in his switches. This precaution was taken to prevent throwing long loads upon the power house machinery without preparation.

The drainage conductors from the 14 acres of roofs over the buildings were provided with jackets within which small steam pipes were run to prevent them from freezing. The ice plant, with a capacity of 20 tons daily, and 800 tons of storage was the means of saving about $8,000 per year. It was designed to take care of 750 trains per day.

This is the first of what we hope will become a most valuable line of papers for record in the proceedings of this society. In the discusion the prominent feature was the concentration of the entire mechanical work in the hands of one firm. The idea was not pleasing to the consulting engineer, but Mr. Kerr, in a most admirable extemporaneous argument, proved conclusively the advantages in such an undertaking as this. There was room for every man who had talent. It was not advisable to use this method everywhere, but in such a case as this it saved endless confusion, and the economy here was $100,000 in $750,000.

The adoption of the Briggs standard dimensions and screw threads for welded tubes of wrought iron by the Master Mechanics' Association, at the convention last summer, was an important step in view of the amount of this material used by the railroads, and especially because of the interchange of freight equipment upon which so much piping is employed. The condition disclosed by the committee, of which Mr. C. H. Quereau of the Denver & Rio Grande was chairman, was most unsatisfactory, and knowing what the standard is there is every reason why all the roads should adopt it. The Chicago, Burlington & Quincy have adopted it.

PRINTING TITLES ON DRAWINGS.

Labor-saving methods in drawing-rooms are now attracting appropriate attention, and one of the ways of saving valuable time is in the mechanical printing of the titles on tracings. In our August, 1899, issue we described a method used by Mr. F. M. Whyte, then mechanical engineer of the Chicago & Northwestern, and now holding a similar position with the New York Central. Mr. Whyte uses a printing press, and the work is done very acceptably by the cheap (office boy) labor. We reproduce Mr. Whyte's letter on this subject as follows:

"In regard to the use of a printing press for printing titles on tracings, we are using a small handpress for this purpose, the frame of which measures 4 by 6 inches. When it was first proposed to purchase a printing press the one we have was considered sufficiently large; but it has been remarked several times since that it would have been better had we purchased a larger once. The length of the frame given above limits the length of the title, but we find it large enough for the purpose, as we try to make the title as short and expressive as possible. We have three fonts of type, and you can judge of their size by the attached print. We find these sizes of type convenient and quite satisfactory. I might tell you our experience which practically drove us to the adoption of a hand press. First, of course, it costs considerable to put titles on drawings whether the work is done with the usual drawing instruments or freehand. To reduce this cost, we tried first to use a rubber stamp, but the ink which we found would work satisfactorily with the rubber stamp would not give a print, so that, after putting the title on with the stamp, we would have to turn the tracing over and ink it on the back with black drawing ink. This, of course, was no great improvement on putting the titles on by hand. We found we could not use black ink on the rubber stamp, because the gasoline used for removal of the ink from the stamp after using it would destroy the rubber type. It was also difficult to get a perfect impression with the rubber stamp. The first difficulty experienced with the hand press was that the ink would not dry fast enough after the title had been put on the tracing, but this trouble was overcome by using a light, fine powder to absorb the ink, so that we now take a print from the tracing immediately after titling it. Fine powder should be used, because, otherwise, the large flakes of coarse powder will overhang the edge of the letter and produce ragged edges. We use the ordinary quick-drying printer's ink for our press. The first cost for us was $22.50 for the complete outfit, and it is believed that the first month or two's saving would cover the entire expense."

It is necessary to scrape the surface of the tracing cloth for the reception of the printed titles if the drawings are made on the glossy side. Mr. Whyte has sent us the following list for requisitions of printing equipment as used by him, all of which may be obtained from the concern mentioned below:

1 No. 2 Official press 4 by 6 inches.
3 Hemple quoins and one key.
1 lot assorted wood furniture.
5 lbs. 2-point L. S. slugs.
5 lbs. 2-point L. S. leads.
1 8-inch composing stick.
1 8 by 12 inch ink stone.
1 font 6 point combination Gothic type No. 1532.
1 font 18 point combination Gothic type No. 1524.
1 font 12 point combination Gothic type No. 1526.
2 fonts 2 point brass rule.
3 small cases two-third, size (for type).
1 lb. can quick-drying printer's ink.

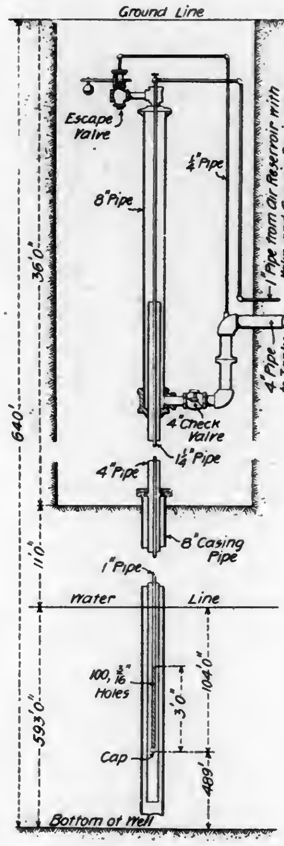
For the benefit of a number of correspondents who have inquired about this method we would state that the press referred to, which is efficient and strong and specially well adapted to such work, was furnished by The Crescent Type Foundry, 346 Dearborn St., Chicago, Ill.

AN AIR-LIFT PUMP.

St. Paul & Duluth Railroad.

Mr. G. D. Brooke, General Master Mechanic of the St. Paul & Duluth Railroad, some time ago devised an application of compressed air to the pumping of water at the Gladstone shops of that road, which is worthy of note. It is an adaptation of the well-known air lift to conditions, under which a deep well pump had not given satisfaction.

The engravings illustrate the plan. The well has an eight-inch casing, driven to a depth of 750 feet, but now partly filled up with silt, making the depth 640 feet. Formerly a deep well pump with a 36-foot pitman was used. This caused considerable annoyance by requiring constant attention, repairs and in replacing this arrangement the location of the well near the stationary boiler plant and in the midst of the shop buildings was found unfortunate, because it necessitated forcing the water underground horizontally to a distance of more than 500 feet to the road water tanks. It would have been better to erect a tank directly over the well, making a vertical lift and then allow the water to flow to the road tanks by gravity. This plan, however, was not followed, for the reason that a fire in the vicinity of the tank over the well would render the water service inoperative.



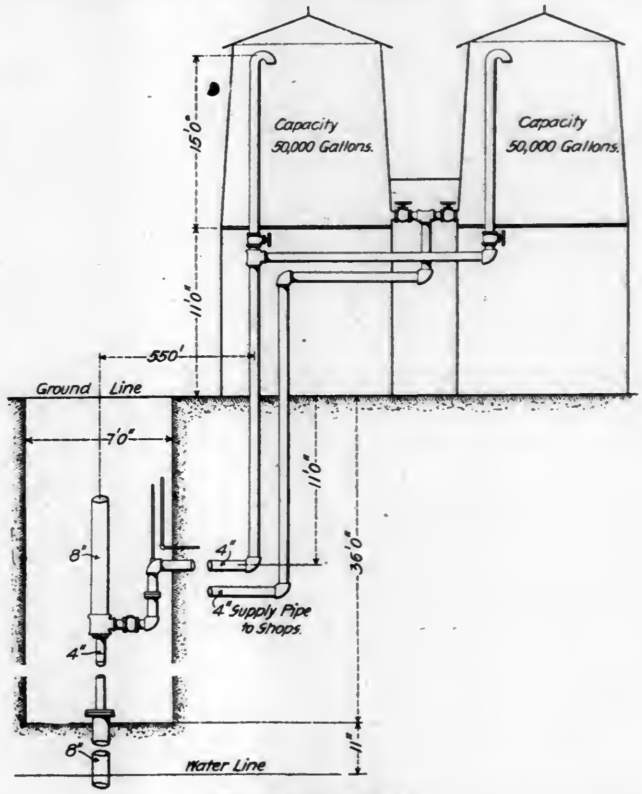
Well Piping.

The arrangement, as installed, places all the apparatus underground, except where there is no liability of fire. The air supply is furnished by a Rand Duplex compressor, and in case of fire in the stationary engine plant supply connections provided for the purpose may be attached for the temporary use of air pumps on locomotives in the round house.

When the air-lift was first started it was the intention to allow all of the air to escape at the over-flow in the water tank, but it was found that the pulsations were so uniform and rhythmical as to cause the tanks to vibrate so severely as to threaten the collapse of the supports if it was allowed to continue. An eight-inch pipe was then added, as shown in the print at the top of the well, and it was fitted with a balance escape valve, which allows the escape of a large portion of the air and retains only enough pressure to force the water horizontally to the tanks and raise it through the remainder of the lift. This arrangement also insures a more solid body of water through the horizontal pipe. Since this change was made, about two years ago, the apparatus has not been changed or even examined in any part, so perfectly has it operated. Mr. Brooke writes that he uses from 80,000 to 100,000 gallons of water per day, the cost of pumping being between five and six cents per thousand gallons. The use of a gravity flow for this horizontal distance would have cheapened the cost, but as it stands, it is not excessive for a lift of 73 feet. The air pressure in the shop piping is 125 pounds per square inch, which is throttled down through a one-inch globe valve to a pressure of 60 pounds for the pumping. A small fraction of a turn of this globe valve supplies enough air from the pressure of 125 pounds to keep a constant stream of water flowing into the tank.

In the drawing it will be noticed that the top of the eight-inch well casing has a tight flange connection with the four-inch pipe; this was not necessary for the perfect working of the device, but it was done to prevent water or dirt from the open well from passing down into the casing, as the water is used for drinking purposes.

As the four-inch pipe and the one-inch air pipes are suspended in the well casing from the top end, double thick galvanized iron pipe was used for this portion to insure against rusting and breaking off and dropping down into the well. The resistance due to 100 feet of water is sufficient to prevent undue vibration of the pipes, which might be caused by the escaping of the compressed air.



Piping to the Tanks.

The number and size of motors to use in equipping a shop with electrical machinery is always an interesting problem. An account of the plan worked out for the new Porifirio Diaz shops of the Mexican International Railway, described in the "Railway and Engineering Review," states that in this case the shafting and machinery of the shops are divided into 10-horse-power units, each unit being driven by a separate motor, while larger or smaller motors will drive individual machines wherever circumstances require. There is an advantage in using a number of motors of uniform size on account of replacements, and it would seem to be possible to group machines favorably for 10-horse-power units. This should be done in such a way as to necessitate using only a few of the motors for ordinary occasions requiring overtime working. The selection of the size of motors is important because the cost per horse-power of the motor increases as the power decreases.

The Hummel system of picture telegraphy is described by Mr. Pierce D. Schenk in a recent number of "The Yale Scientific Monthly." The pictures are drawn with insulating ink on tin-foil and the transmitting and receiving instruments pass in horizontal lines over these plates in synchronous movements. The transmitting current is interrupted at the lines of insulating ink, and the reproduction is made to follow the original. The greatest difficulty was found in synchronizing the two machines. Mr. Schenk illustrates the circuits and instruments with a diagram.

THE OIL ENGINE.

It is about ten years since the first English internal combustion engine, using heavy oil, was brought to the point of success. It was a Priestman engine tested by Prof. Unwin in 1890. burgh, whereby the progress made in this field may be seen, are printed in recent issues of "The Engineer." The Priestman engine referred to made several records, but there is no doubt but that it produced a brake-horse-power for a consumption of one pound of oil. The oils used in the tests were "Daylight" and "Russolene."

At the recent Edinburgh trials 10 engines were tested and satisfactory tests were obtained with nine. There were seven distinct makes. The results are given in the accompanying table, which is of special interest because of the scarcity of data pertaining to oil engines. These tests were made at the Edinburgh exhibition of the Highland Agricultural Society of Scotland. The power was measured by the Prony brake and the indicator, and the oil consumption was measured. The engines were run four hours at the full brake load and two hours at half load. They were afterward run one hour at light load and finally for a short time at the maximum load which could be depended on in an emergency. The Crossley, Stephenson, Pollock and Cundall engines used "Royal Daylight" oil of 0.796 specific, while the others used "Russolene" oil of 0.825 specific gravity.

The average consumption of six of the engines is 0.958 pound per brake-horse-power per hour, which is a small improvement over the earlier results. Four of the engines gave 15.5, 18.93, 12.6 and 18.06 brake-horse-power, respectively, and their mechanical efficiencies were 0.771, 0.773, 0.858 and 0.842, which appears to indicate that these variations in power were not sufficient to affect the efficiencies materially. In other words, the size of the engines, within these limits, does not affect the efficiency.

The half power trials are specially interesting. There were six types of engines represented and the average oil consumption at half power was 1.36 pounds per brake-horse-power hour. One engine used 2.23 pounds. Omitting that, the average would be 1.18 pounds for half power as compared with an average of 0.96 pound for the full load consumption. In overloading it was found that nearly all of the engines developed 25 per cent. overload. No generally satisfactory figures of speeds and pressures were obtained. The generally accepted opinion that high speeds were favorable to high efficiencies because of the short time in which a charge remained in contact with the cylinder was not borne out by the tests. It was found that the best results were given by an engine which ran relatively slowly, while the worst results came with the highest speed. This is not considered by any means conclusive evidence in favor of slow running, however. The tests indicate an improvement in the oil engine, though not very marked or rapid. The wide differences in the opinions as to elementary proportions indicate that the best practice has probably not yet been reached. Ten years is much too short a time to expect to achieve the crystallization of practice which has taken place in marine and other fields of steam engineering.

Summary of Trials of English Oil Engines.

Engines.	Crossley Brothers Limited.	Camp. bell Gas Engine Co.	Campbell gas Engine Co.	R. Stephenson & Co.	Blackstone & Co.	Blackstone & Co.	Blackstone & Co.	Tangyes Limited.	Pollack. Whyte & Waddel.	R. Cundall & Son.
Diameter of cylinder, inches	10	12½	9½	7	6	7	9½	11	10	8¾
Stroke, inches	18	21	18	12	12	14	18	16	18	15
Full-power trial:										
Revolutions per min., mean	204	188	210	252	256	218	190.3	200.1	220.5	227.7
Mean effective pressure, lb. per sq. in	64.52	49.5	..	39.	..	..	56	62.2	..	..
Explosions per min., mean	87.25	76	..	118.5	..	..	81.4	89.75	..	..
Indicated horse-power	20.09	24.48	..	5.39	..	..	14.68	21.43	..	..
Mechanical efficiency	.771	.773	..	.582	..	..	.858	.842	..	..
Brake horse-power	15.5	18.93	13.87	3.14	5.21	8.13	12.6	18.06	10.64	8.77
Oil per B. H. P. per hour, lb	.793	1.20	1.06	1.63	.833	.836	.746	.806	1.15	.962
Half-power trial:										
Brake horse-power	7.71	10 59	6.73	1.31	2.84	4.84	6.59	9.95	4.69	4.35
Oil per B. H. P. per hour, lb	1.037	1.466	1.186	2.88	1.099	1.03	1.024	.939	2.23	1.57
Light trial:										
Total oil used per hour, lb	4.03	8.23	3.8	4.43	1.69	2.75	3.4	3.375	5.375	4.24
Maximum-power trial:										
Brake horse-power	18.01	25.55	14.89	3.14	6.68	10.66	19.7	20.66	19.85	10.54

The standardization of the threads of small screws was discussed at the recent meeting of the British Association, and among the interesting facts brought out was the difficulty of making accurate gages for small screws having rounded portions at the top and bottom of the threads. The Sellers standard differs from the threads usually cut on small screws, and also with the Whitworth standard, in this particular. The Sellers standard appears to be gaining friends. It has been adopted by the French navy, and also by several railroads of that country. This system, using flat ended threads, is admirably adapted to accuracy in making gages, and it is possible that further action of the British Association may favor its adoption. It is evident that this organization considers its previous selection of round ended threads as unsatisfactory, and the subject is to receive further attention by the committee having it in charge. The report contains the statement that: "As far as easy production of the correct form is concerned, arguments which apply to large screws apply with greater force to smaller screws, while a form which is suitable for all screws above 6 millimeters diameter, the maximum diameter in the British Association list, cannot be unsuitable for screws below that diameter."

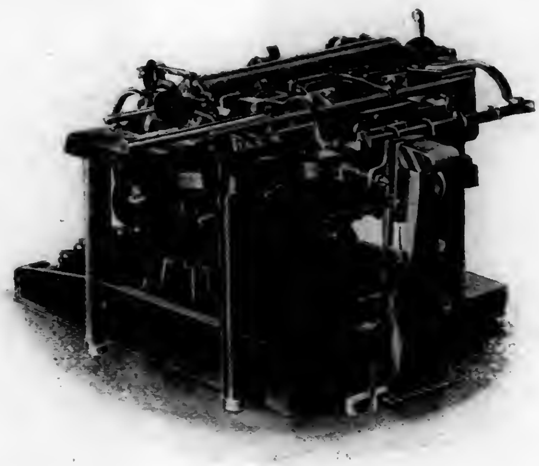
THE NEW REMINGTON BILLING AND TABULATING ATTACHMENT.

An ingenious and exceedingly valuable improvement has been applied to the Remington Standard Typewriter, which will be an important labor saver in offices where statistical and tabulated work is done. For railroad offices it will be invaluable in preparing reports, records and specifications, one operator working with the attachment can do the work of about five without it, and the arrangement is designed throughout to avoid interfering with the regular operation of the machine. The purpose of the device is to enable operators to arrange tables in columns without the necessity of setting the carriage of the machine by hand. Stops are applied in such a way as to bring the carriage to the desired point by a single movement of a key.

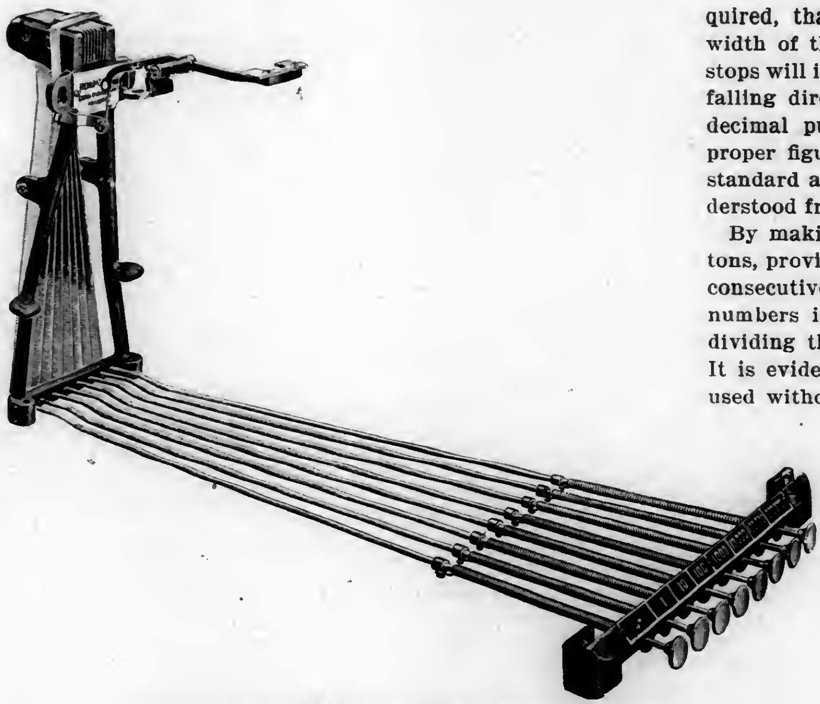
As illustrated in the engraving, the attachment is applied to the machine by small castings fastened to the frame, one under the front of the base below the keyboard and the other in the form of a bracket at the rear of the machine. An additional graduated bar is supported upon the back of the carriage by light brackets, the graduations in this bar being made to correspond with the other graduated scales. Upon this graduated bar small stops may be secured in any desired position for fixing the location of the columns of figures, and these may be changed at any time. Supported in a case in the rear of this bar are a number of plungers, any one of which may be drawn forward horizontally by means of the corresponding push button at the front of the machine below the keyboard. Upon pressing one of the push buttons the pinion which holds the carriage in the ordinary working of the machine is disengaged and the carriage moves along under the impulse of the main carriage spring, which constantly

urges it toward the left. The push button at the same time projects its plunger forward into the path of the stops, and the motion of the carriage is arrested by the stop at the point determined by the push button, which has been operated. For proper distance away for the first figure of the desired number. If it is 100, the carriage stops three spaces away, and four spaces if it is 1,000.

It will be noted that no hand setting of the machine is re-



The Remington Billing and Tabulating Attachment.



The Remington Billing and Tabulating Attachment.

example, if 100 is to be written, the 100 button is pushed and the carriage moves at once and is arrested at the space determined by the location of the stop on the back of the machine necessary to bring the first figure in its proper place in the column. If three columns of figures are to be arranged across the page the stops are placed at the proper places in the rack and the operator starts with the carriage at its extreme right-hand position. The push-button corresponding to the first figure in the first column is pushed and the carriage immediately takes the position desired. The proper numerals are then written from the keyboard, and, upon pressing the push button to locate the first figure in the next column, the carriage at once moves over the intervening spaces and stops at the correct position for the first figure desired for that column, the same process being repeated for the third column. The basis for the columns is a fixed point, which in the standard arrangement is the decimal. The decimal plunger stops the carriage at that space and the other plungers stop it at the

quired, that the number of columns is limited only by the width of the paper and the size of the machine, and that the stops will insure the determining spaces for each line of figures falling directly under each other. For decimal fractions the decimal push button is used, the period is struck, and the proper figures inserted. There are eight push buttons in the standard arrangement, and their operation will be readily understood from the engravings.

By making slight changes in the marking of the push buttons, provision may be made for placing the number characters consecutively, for spacing them for commas to divide large numbers into hundreds, for using the monetary sign, or for dividing the figures for pounds, shillings, and pence sterling. It is evident that a large variety in the arrangement may be used without changing the number of the plungers, and more plungers may be added if necessary. For certain kinds of work requiring several different settings of the stops a graduated bar may be used, which is arranged to be revolved into any one of four positions, bringing into play in each position a separate set of stops fixed for the special requirements. For ordinary use the removable stops are preferred, because they may be placed in any notch in the graduated bar. When put in position these stops lock themselves, so that they cannot be jarred out of place and yet they may be easily removed by the thumb and finger. The improvement was brought out about a year ago and has been brought to a satisfactory working condition. Mechanically, the device is well designed. It does not interfere with any operation that could be done before, and it may be very quickly applied to any of the recent models of these machines.

EXTENSION OF SEVEN MONTHS FOR SAFETY APPLIANCES.

The extension of the time for equipping cars with automatic couplers and air brakes, petitioned for by the railroads, has been granted by the Interstate Commerce Commission, and the date thus fixed is August 1, 1900, an extension of seven months. Expected progress has not been made by a number of roads because of the difficulty of procuring the necessary material and also because of the enormous traffic of recent months, which made it impossible to get the cars into the shops for making the attachments.

PERSONALS.

Mr. S. B. Mason has been appointed Assistant to the Mechanical Superintendent of the Baltimore & Ohio, with office at Mt. Clare, Baltimore, Md.

Mr. W. S. Haines has been appointed Division Master Mechanic of the Baltimore & Ohio, at Newark, Ohio, to succeed Mr. W. H. Harrison.

Mr. H. E. Yarnall, Purchasing Agent of the Choctaw, Oklahoma & Gulf, has removed his office from South McAlester, I. T., to Little Rock, Ark.

Mr. H. V. Mudge, General Superintendent of the Atchison, Topeka & Santa Fe, has been appointed General Manager of that road, with headquarters at Topeka, Kan.

Mr. F. S. Chandler, formerly Purchasing Agent of the Ann Arbor, has accepted a position in the office of General Superintendent Stout of the Wheeling & Lake Erie.

Mr. C. E. Fuller has resigned as Superintendent of Motive Power of the Central Vermont, and has been succeeded by W. D. Robb, hitherto Master Mechanic of the Grand Trunk at Toronto.

Mr. James H. Maddy, who has done such valuable work as Press Agent for the Baltimore & Ohio, has been rewarded by appointment to the position of assistant to General Manager Underwood.

The office of Master Mechanic of the Lake Shore & Michigan Southern, at Buffalo, N. Y., has been abolished, and the jurisdiction of Master Mechanic A. A. Bradeen is extended to include the entire Eastern and Franklin Divisions.

Mr. F. H. Clark, Chief Draughtsman of the Chicago, Burlington & Quincy, has been appointed Mechanical Engineer of that road, with headquarters at Aurora, Ill., and will be succeeded as chief draughtsman by Mr. C. B. Young.

Mr. Malcolm H. Wallace, Chief Clerk of the Motive Power Department of the Northern Pacific, has resigned to accept the position of Chief Clerk to Mr. E. M. Herr, General Manager of the Westinghouse Air Brake Company, at Pittsburg.

Mr. G. J. Fisher has resigned as Purchasing Agent of the Fitchburg, to take effect on January 1. He has held this position for the past 12 years and was formerly Purchasing Agent of the Eastern Railroad and the Boston & Maine.

Mr. William F. Merrill, Second Vice-President of the Erie, has been chosen First Vice-President of the New York, New Haven & Hartford, to succeed Mr. William D. Bishop, Sr., who has been filling the position temporarily since November 11. Mr. Merrill will have direct charge of the line and its operation.

Mr. S. S. Voorhees, who has been chemist of the Southern Railway for the past five years, has been appointed to a similar position on the New York Central at West Albany. His experience before entering the service of the Southern Railway was with Dr. C. B. Dudley, with the Pennsylvania, at Altoona. He is a graduate of Lehigh University.

J. Charles Cox, the news of whose death, in November,, reached us after the publication of our December issue, was 72 years of age. He died in Pittsburgh, where for many years he was employed by the Pittsburgh and Connellsville Railroad. He was subsequently connected with the Baltimore & Ohio when that road absorbed the Pittsburgh & Connellsville.

Recent changes in the operating department of the Chicago & Northwestern are as follows: Mr. J. M. Whitman, for many years General Manager, has been made Fourth Vice-President; Mr. W. H. Gardner, Assistant General Superintendent, has been appointed General Manager; Mr. Sherburn Sanborn, General Superintendent, has been appointed Assistant General Manager, and Mr. R. H. Aishton, Superintendent of the Iowa Division, has been appointed General Superintendent.

John I. Blair, the veteran railway builder and owner, died at his home in Blairstown, N. J., December 2, at the age of 97 years. He began his career as a railroad builder in 1839 in a connecting link between Oswego and Ithaca, N. Y. This line, with others which he aided in building, was finally merged into the Delaware, Lackawanna & Western, in which he was a director at the time of his death. He was prominently connected with the construction of many of the important roads in the West.

Colonel Julius Walker Adams died at his home in Brooklyn, N. Y., on Dec. 14. He was one of the most brilliant and enterprising men in the field of civil engineering. He was instrumental in establishing civil engineering on this continent as a profession and was one of the fathers of the American Society of Civil Engineers. In 1846 he was Superintending Engineer of the New York & Erie Railroad, for several years Consulting Engineer of the City of New York, and prior to this time was Chief Engineer of many other Eastern roads. Colonel Adams was born in Boston, Oct. 18, 1812, and has lived a life of such usefulness that one cannot but feel the great inspiration his life and work has been to the engineering world.

BOOKS AND PAMPHLETS.

Masonry Construction. By Ira O. Baker, C. E., Professor of Civil Engineering, University of Illinois. Ninth edition, revised and partially re-written; first thousand. Published by John Wiley & Sons, New York, 1899.

This book has long been a standard work, and an acknowledged authority on foundations. The present edition is a revision for the purpose of bringing the text on cements, mortars, concrete, etc., up to the present state of knowledge on those subjects. The treatment of cement tests and cement specifications is as complete as one could wish; the same cannot be said of the discussion of concrete, but the indefinite state of knowledge on this latter subject makes it very difficult to secure reliable data. It is noticeable that no information is given regarding the expansion and contraction of concrete with changes of temperature.

The importance of allowing for the expansive force of concrete is shown by the experience of some cities where concrete walks have been laid abutting against the street curbs at crossings, and have by their expansion broken the curbs. Examples of this action may be seen in Indianapolis, and also in Grand Rapids, Mich. At Ann Arbor, Mich., the expansion in a concrete walk one-quarter mile in length was sufficient to cause buckling at one joint, the joint being forced upwards six or eight inches, leaving the two adjacent blocks of concrete inclining against each other. The importance of this element in concrete is also emphasized by the growing use of Melan and Thacher arches of steel and concrete combined, in which the stability of the structure depends to some extent upon the assumption that the coefficient of steel and concrete is practically the same, a very doubtful assumption. Spaulding says that the coefficient of expansion of neat cement is the same as steel. It would seem, then, as though it would be considerably less for concrete, with its large proportion of stone with low coefficients of expansion.

The book may be criticised for neglecting in a discussion of arches, which in other respects is quite broad, any mention of Melan and Thacher bridges, or arches of concrete, when everything seems to point to the rapid development of these structures for highway bridges.

Some important data are given regarding the relative

strength of Portland and natural cements which does not uphold the doubtful theory held by some, that natural cement concrete becomes stronger in time than Portland cement concrete; but the proof is not conclusive. Outside of these few points the text is most satisfactory and complete.

The absorption of water by cements and concrete, with means of prevention, and the effect of freezing on concrete, are discussed at some length. A chapter has been added on sand, gravel and broken stone, with methods of determining the voids for a proper proportioning of cement in the making of concrete.

Although the present edition is a revision with reference to mortar and concrete, it may not be amiss to notice one conclusion that the author has drawn in his discussion of arch culverts, and which might with advantage have been omitted from the revised edition. The conclusion is that because semicircular arch culverts have usually been built with heavier abutments than would be required to resist the thrust of the arch, that therefore it may be concluded that the pressure of the earth-fill against the abutments is far greater than the thrust of the arch; and therefore segmental arch culverts, on account of the greater thrust of the arch to balance this pressure, may be built with lighter abutments than semi-circular ones. It may be true that such is the case, but some more substantial proof is needed to be convincing. And such a conclusion drawn from inspection of existing structures is not only unwarranted but is dangerous.

The Stereopticon Method of Examining and Instructing Railway Employees. By W. J. Murphy, Superintendent C., N. O. & T. P. Ry., Lexington, Ky., 1898. 54 pages, 4½ x 6 inches.

This little book contains questions and answers, engravings and descriptions of the stereopticon method of training and examining railroad employees in regard to the rules governing railroad operation and the management and use of railroad equipment. The author devised this method some time ago, and put it into use on the Cincinnati, New Orleans & Texas Pacific Ry., where it has been very successful. The underlying idea is to instruct and examine the men under conditions as nearly as possible like those of actual visits to the various points protected by signals, and by aid of photographs thrown upon the screen the instructor and examiner is enabled to place actual conditions before the men in a way that could not possibly be attained by diagrams or, in fact, by any method except by actually taking them out on the road to the places where the complications in signals and dangers are to be found. This is manifestly impossible on a large road, but by means of the screen these places are practically brought into the room and placed before the men. Mr. Murphy does not confine his attention to signal and train rules, but reaches out into the subject of breakdowns to locomotives and the handling of wrecks. These matters are not presented in detail or in large variety in this little book, but the treatment is sufficient to indicate the possibilities of the plan. Mr. Murphy's method of examining men as to color blindness and strength of vision by aid of the stereopticon is also shown. This idea of the use of the screen and lantern is believed to be a thoroughly good one, and every railroad officer having to do with the operation of trains should obtain a copy of the book. The idea of the plan is to instruct new men intelligently as to their duties and periodically examine those in service as to their knowledge and understanding of the rules.

Hall's Tables of Squares. Containing the True Square of Every Foot and Fraction Thereof, from 0 to 100 Feet, Advancing by One-sixteenth of an Inch. By John L. Hall. The Engineering News Publishing Company, 220 Broadway, New York; 200 pp., leather, size 3½ by 5¾ inches, 1899. Price, $2.00.

This is a most convenient table of squares. It is a durable and attractive book, well suited for the use of engineers, and possesses several important improvements over other tables of squares. This table is stated to be correct to the sixth decimal place instead of merely to the second or third place, which is the limit of other tables with which we are familiar. The compass of this work is heartily commended. It gives the squares up to 100 feet, whereas 50 feet is the limit of previous tables. An admirable feature of its arrangement which will be appreciated at once is the paging. The page numbers correspond with the number to be squared and the squares of any particular foot and its fraction are exposed to view on two facing pages. This is accomplished by numbering only the left-hand pages. A comparatively small matter of this kind makes all the difference between convenience and inconvenience, and this has a great deal to do with the success of such a work. The arrangement of the columns is also good. Each inch has a column by itself, separated into quarter inches by blank spaces, with the roots printed in heavy-faced type. The clearness produced by this arrangement is unusual. These are an improvement over Buchanan's in that in the present work the fraction is squared first and then reduced to decimal form, whereas Buchanan took for the basis of his tables the approximate 4-place decimal equivalent of each fraction of a foot. Mr. Hall points out that the resulting squares, if absolutely accurate to the eighth decimal place, yet, by reason of the inexactness of the roots employed, differ from the true squares in eleven cases out of every twelve and frequently at the second or third decimal place.

Fowler's Mechanical Engineer's Pocket Book for 1900. Edited by William H. Fowler. Price, $1.00. Published by D. Van Nostrand Co., 23 Murray St., New York.

The success of this book last year has resulted in an increase of matter covering 200 pages, 80 of which are added to the treatment of electrical subjects. The book contains a great deal of valuable information which, even with the present large number of "pocket books," we have not seen in any other publication. Its strong points seem to be such information as would be expected with such assistance as that of the former Chief Shipwright of the Board of Trade and Professor Pullen. The tables of properties of saturated steam are unusually complete in range, for the purpose of providing for the recent great advances in steam pressures. The tables in this volume range from 1 to 300 lbs. per square inch with intervals of one pound, and all the quantities involving the mechanical equivalent of heat are based on 778 foot-pounds, the most recently accepted value. This work was done by Professor Pullen. The other most important additions concern steam boilers, machine tools and textile machinery. The index is satisfactory, covering nearly 50 pages. The price is exceedingly low, and for this reason the presence of a large number of advertisements may be excused. We must criticise the omission of the name of the book upon the binding where it may be seen on the shelf. Doubtless this will be attended to in future editions.

The Building and Ornamental Stones of Wisconsin. By E. R. Buckley, Ph. D., Assistant Geologist Wisconsin Geological and Natural History Survey. Published by the State of Wisconsin, Madison, 1898.

This volume, which has been received through the courtesy of Mr. E. A. Birge, Director of the Wisconsin Geological and Natural History Survey, will be invaluable to those interested in the geology of Wisconsin. It treats of the demand, uses and properties of ornamental stones; the geological history of Wisconsin, and description of the areas and quarries. The appendix contains a study of the composition and kinds of stones and rock structures. The volume presents results of a large number of tests and by aid of handsome engravings and colored plates shows not only the character of the Wisconsin building stone, but its effect in architecture and the methods of quarrying and preparing for use.

Interstate Commerce Commission. Eleventh Annual Report on the Statistics of Railways In the United States for the Year Ending June 30, 1898. Prepared by Mr. Henry C. Adams, the Statistician to the Commission. Government Printing Office, Washington, D. C. 1899.

This report covers the ground of railroad statistics in accordance with the plan adopted by the commission and brings the record up to a little over a year ago. It appears to have no new features, but is undoubtedly improved in accuracy by the efforts to secure data in a uniform manner from the various combinations of roads which naturally tend to obscure the identity of some of the individual lines. It contains the report of the statistician, statistical tables; a summary of railroads in the hands of receivers, with the capital involved; decisions of the commission upon questions raised under the classification of operating expenses, and two indexes, one to the railroads and the other a general index to the volume.

Report of the 18th Annual Meeting of the American Street Railway Association Held in Chicago, October, 1899. Mr. T. C. Pennington, Secretary, 2020 State Street, Chicago, Ill.

This pamphlet of 220 pages contains the minutes and proceedings of the recent meeting of the association, with complete information concerning the membership, and includes the papers and discussions of the meeting.

Locomotive sanders are illustrated and described in a pamphlet of 30 pages received from the American Locomotive Sander Co., 13th and Willow streets, Philadelphia. The devices described are the Leach, Houston, Dean, "She" and Curtis. These well-known sanders are all described in detail by the aid of line drawings showing sections of the apparatus.

The Rand Drill Co., 100 Broadway, New York, have issued two very handsomely illustrated pamphlet catalogues, one entitled "Rock Drills and Drill Mountings," and the other, "Air and Gas Compressors." The first is devoted to the rock drill in its various forms for mines, quarries and tunnels. It contains a history of the rock drill, descriptions of the machines manufactured by this firm, illustrations of different kinds of works, and valuable information for use in connection with this work. The compressor catalogue illustrates the Rand Air Compressor in its many forms and applications, the descriptions of which include tables of information concerning sizes and capacities. The accesories to compressors, reheaters, air engines and governing appliances are included, and also a number of tables of information concerning the compression and use of compressed air. The engravings are unusually fine; nearly all are half-tones.

Westinghouse Pneumatic Control; New Motor Trucks and Rotary Air Compressor.—The Westinghouse Air Brake Co. have issued a most handsomely illustrated pamphlet on these subjects. The pneumatic control system for elevated railroads is described in detail and by aid of the engravings the operation of this ingenious system is made clear. The object is to use motors under any desired number of cars in the train which may all be controlled from the motorman's compartment of any of the cars. The controllers are operated by pneumatic power acting in small cylinders, the operating valves of which are controlled by currents from primary electric batteries. The system uses the principles of the Westinghouse electro-pneumatic interlocking apparatus and in a really simple system permits of obtaining the advantages of multiple unit control of an electrically driven train. The pamphlet also describes the air brake system applied to such service, which is a modification of the standard apparatus used in heavy railroad service and the new rotary air compressor which is driven directly by a motor placed with its armature horizontal. Heretofore the independent compressors for elevated car service have been of the reciprocating piston type and driven by gears or other noisy mechanisms. This is a rotary air pump and the motor is made specially for use in connection with it. We also find an illustrated description of the new Baldwin-Westinghouse motor truck (See American Engineer, November, 1899, page 356) and several engravings of the large Westinghouse railway motors used in recent practice. The pamphlet is the handsomest that we have seen in such literature, and is in excellent taste throughout.

EQUIPMENT AND MANUFACTURING NOTES.

The Chemins de fer de l'Etats Neerlandais, at Utrecht on the Rhine, has adopted Nels' yellow semaphore signal lights and has ordered the glass from Mr. John C. Baird of Boston.

The Chicago Pneumatic Tool Co. announces the dismissal of patent litigation entered into between that company and Joseph Boyer with the Standard Pneumatic Tool Co. and the Chouteau Manufacturing Co. The announcement states that the parties concerned have purchased licenses from each other covering their present styles of hammers, a step which was considered necessary for the protection of users of their products. This action will prevent the annoyance from infringement claims.

Mr. Wallace W. Johnson, who has been associated with the Keasbey & Mattison Company for a number of years, has resigned to become connected with the Franklin Manufacturing Company of Franklin, Pa.

The Bullock Electric Manufacturing Co. have begun the extension of their main shop building by the addition of 200 feet to its length. This will make the main shop 500 feet long by 101 feet wide. The increase in facilities has been necessitated by increasing volume of business coming from all parts of the world.

The electric car lighting system of the Columbian Electric Car Lighting and Brake Co. of 11 Broadway, New York, of which Mr. J. L. Watson is secretary, is now in operation on the following roads: The New York Central, Pennsylvania, Baltimore & Ohio, Boston & Albany, Union Pacific, Rutland, Illinois Central, Lake Shore & Michigan Southern, Canadian Pacific, Cleveland, Cincinnati, Chicago & St. Louis, and also by the Pullman and Wagner companies. The system was described in our December, 1899, issue.

The Q & C Co. sent us the following statement in regard to patent litigation concerning pneumatic tools: "Referring to the articles now appearing in the mechanical papers pertaining to litigation on pneumatic tools, and in order to make clear the position of the Q & C Co., we wish to distinctly state that we are not in any way involved in this controversy. The line of tools manufactured by us are protected by our own patents, unique and broad in themselves and absolutely clear from any infringement. Full protection will be given to any purchaser of our tools from any liability on account of their use."

The Cling-Surface Manufacturing Company, of Buffalo, N. Y., report a recent letter from the Peoples' Electric Light, Heat and Power Company, of Greenville, Pa., which says that Cling-Surface gives the best of satisfaction. "One of our 16-inch belts is running with a 21-inch sag. Another 16-inch belt, 8 feet shorter, is running with a 19-inch sag. One of our 12-inch dynamo belts has been run ten years and is a 'dead belt'; we had to cover the pulley or run it very tight. We have been using Cling-Surface on it and no pulley covering, and now it with 8-inch sag and think we can get it down further. Two other 12-inch 'dead belts' are also running very slack."

Having noticed printed references to a circular issued jointly by two manufacturers of pneumatic tools, stating that the patents controlled by them cover the fundamental principles of pneumatic hammers, without which no successful ones can be made, the Q & C Company desires not to express any opinion as to the accuracy of the statement when applied to valved hammers, but to state that it is misleading when valveless hammers are included. They also desire to state that the valveless hammers manufactured by them are not in any way an infringement of the patents referred to.

An index for the M. C. B. book of rules has been prepared by the Sargent Company, 675 Old Colony Building, Chicago, and will be distributed to railroads for the use of those having occasion to refer to the rules. This index is arranged to fold into the book of rules and is provided with a gummed strip for attachment to the page. On the reverse side of the slip is a copy of the Sargent Company's knuckle chart illustrating 59 of the M. C. B. coupler knuckles, which this concern is prepared to furnish. The idea is a good one, and the indexes will undoubtedly be thoroughly appreciated among the railroads. Copies will be furnished upon application to the Sargent Company.

The Bullock Electric Manufacturing Co. report for November, 1899, the largest amount of business in a single month in the history of the company. Fifty-one machines were sold, several of which were "repeat" orders. The more important sales are noted as follows: Willson Aluminum Co., Holcombs Rock, Va., three 600 k.w. alternating generators; Manchester Sporting Chronicle, of Manchester, England, two 150 k.w. direct current generators (second order); L. L. Summers, Florence, Colorado, six direct current generators aggregating 260 k.w.; John Wanamaker, Philadelphia, Pa., one 100 k.w. direct current generator, and three 50 horse power "Teaser" printing press equipments; Arthur Pearson, Pearson's Magazine, London, England, three 50 horse power "Teaser" printing press equipments; Oakland Transit Co., Oakland, Cal., four 15 horse power direct current motors (third order); American Type Foundry Co., Cincinnati, O., one 30 k.w. generator (second order), and Pacific Coast Borax Co., Bayonne, N. J., one 12½ horse power direct current motor (fifth order).

AMERICAN ENGINEER AND RAILROAD JOURNAL.

FEBRUARY, 1900.

CONTENTS.

LOCOMOTIVE DESIGN.*

By F. J. Cole, Mechanical Engineer, Rogers Locomotive Works.

Firebox Crown Stays.

In this article various forms of the supporting stays or bracing for firebox crown sheets will be considered. The possibility of a crown sheet becoming over-heated by the temporary absence of the usual covering of water requires the supporting bolts or stays to be designed with a larger factor of safety than the water space stays, which are wholly below the level of the crown sheet, and for that reason always entirely submerged.

It is not meant by this that the bolts should be made so large and strong that no amount of over-heating would cause the crown sheet to be blown down. A few moments' consideration would show the fallacy of this. It is good practice, however, to provide a very large margin against any temporary absences of water or over-heating either wholly or in part, caused by: (a) foaming; (b) the application of brakes to a swiftly moving locomotive in momentarily exposing or nearly exposing the crown sheet; (c) by improperly or insufficiently admitting feed water to the boiler, which allows the water level to be so lowered that the intense heat generated in the firebox is not absorbed fast enough to keep the sheet at the usual comparatively low temperature; (d) overheating caused by deposit of scale or mud. The action of the brakes in reducing the water level at the back end is more noticeable in straight topped radial stay or Belpaire boilers than in those having wagon tops. Boilers with straight tops have more steam room in the front and therefore greater space for the water to rush ahead when the motion of the boiler is suddenly retarded.

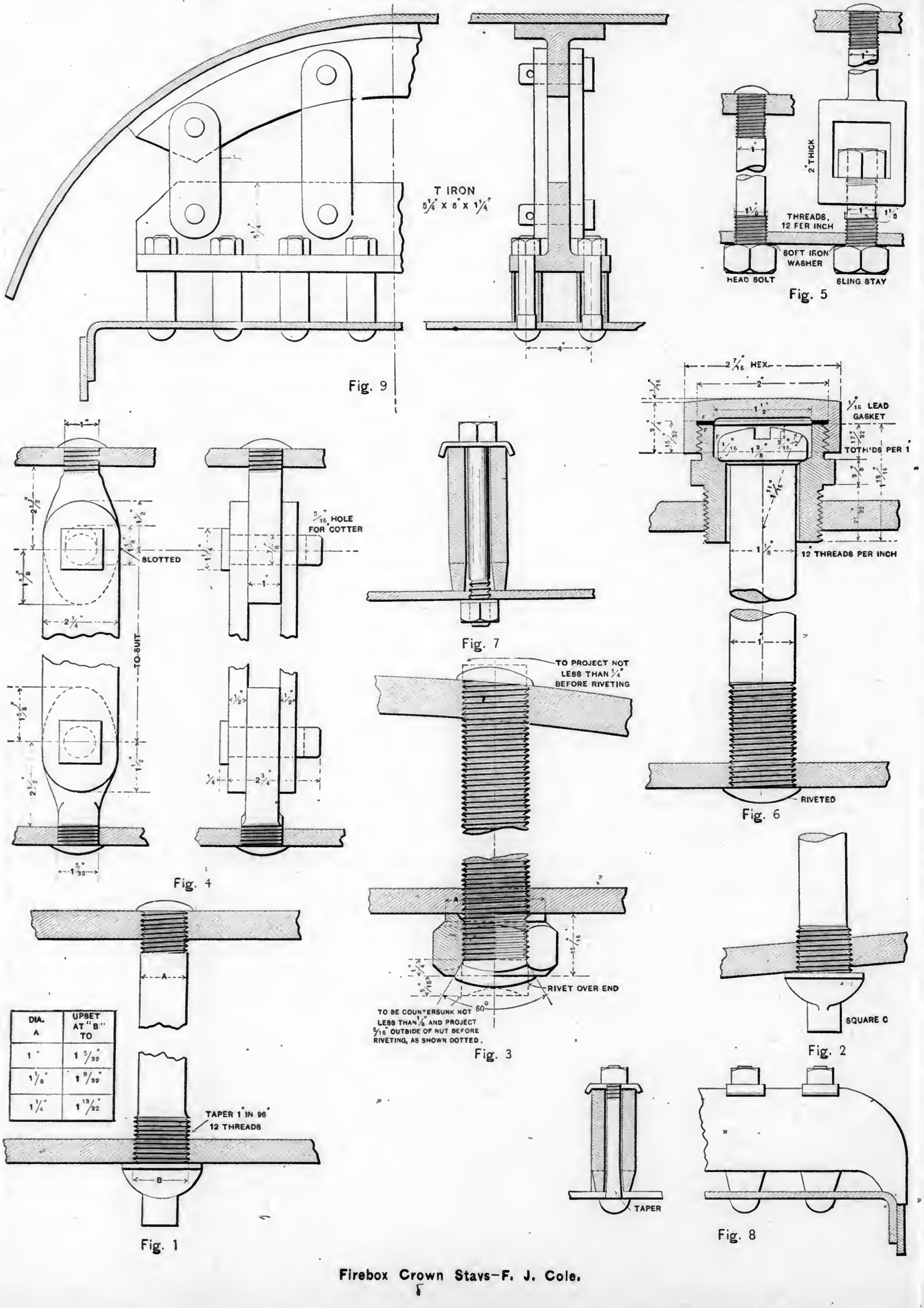
Experience indicates that certain sizes of crown stays give satisfactory results for a given spacing and steam pressure. Also that the upper ends of the bolts or stays may be safely made smaller than the lower ends or parts exposed directly to the heat of the fire. For radial stay and Belpaire boilers 3,500 pounds as an average with a range from 3,000 to 4,000 pounds per square inch of net section will be found a perfectly safe and satisfactory stress for the lower ends, which pass through the crown sheet and are exposed to the action of flame and heat and 5,000 pounds as an average with a range from 4,500 to 5,500 pounds for the upper ends not exposed to flame and heat. For crown bar staying, the fiber stress for the bolts securing the crown sheet to the bars may be safely increased to 4,500 pounds for the lower end, which is exposed to the direct action of flame and heat; and the upper end not exposed to flame and heat to 7,000 pounds of net area.

*For prevoius articlo, see Vol. LXXIII., p. 376.

In Fig. 1 is shown an excellent form of solid button head bolt suitable for radial stay or Belpaire boilers. This form is largely used and makes a first class stay when properly fitted. The lower threaded end is tapered slightly and enlarged about 5/32 of an inch, or just enough to allow the upper end to pass through the lower hole after it is tapped out. The under side of the head is turned true and grooved so that the bearing is on the outside, and the crown sheet spot faced with a cutter, which is provided with a long shank to pass through the inner and outer holes. The diameter of the cutter is not much larger than the bolt head and is arranged to face off the sheet exactly at right angles to the longitudinal axis of the bolts. If this is properly done, the bolt may be screwed in and a steam-tight joint made without bending it under the head, which would otherwise occur, if the holes were not true with the surface of the sheet. See Fig. 2. During the operation of screwing in such a bolt, the head of which touches the sheet at only one point, the neck is alternately bent backwards and forwards at each half revolution until the head is in contact all around. Many instances have been observed in bolts removed from boilers where this repeated bending had caused dangerous cracks just under the head. This is especially the case where the necks had been grooved to facilitate cutting the threads. See tests, numbers 7 to 10 in the table of Record of Tests.

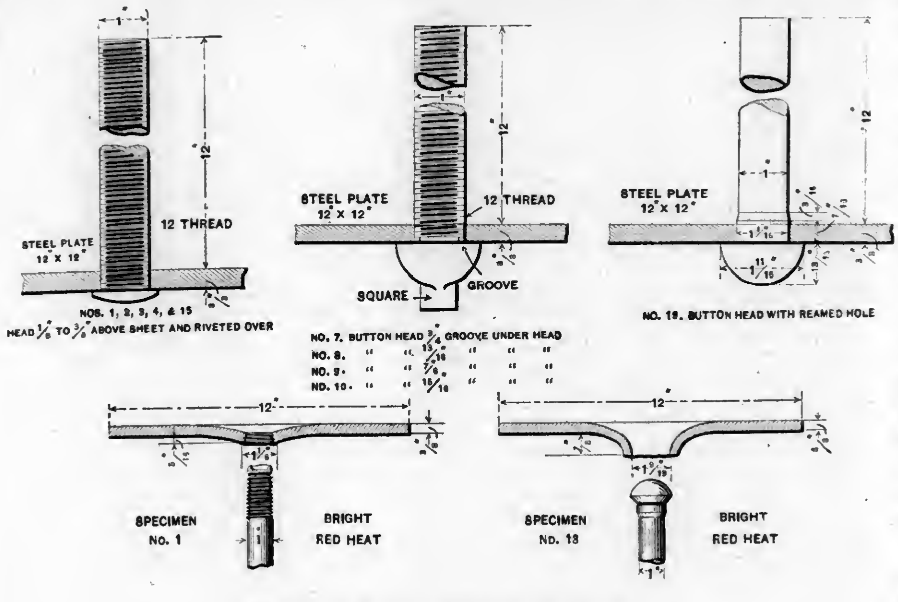
A number of experiments were made by the writer a few years ago to determine the holding power of various forms of firebox crown stays, both hot and cold, with a view to reduce the number of dropped or "bagged" crown sheets. These tests and the conclusions deduced therefrom were published at length in the transactions of the American Society of Mechanical Engineers, May, 1897. A few extracts are given below:

> The object in view was to test them as nearly as possible under the same conditions as in actual service, when used in staying the firebox crown sheet of a locomotive, and particularly to note the relative decrease of the holding power at high temperatures. In all these tests, it is assumed that the bolts are spaced 4 by 4 inches, center to center, supporting an area of 16 square inches.
>
> The pocketing, or bagging down, which is characteristic of an overheated crown sheet caused by low water, was imitated by using a bearing plate of ½-inch steel, 8 by 8 inches square, with a hole 4½ inches in diameter bored through its center. The area of this hole is 15.9 square inches. The specimens were screwed or driven into pieces of ⅜-inch steel plate, 12 by 12 inches square.
>
> A 100,000-pound Riehle screw-testing machine was used, the specimen plate and bolt being inverted with the bearing plate between it and the head of the machine, the staybolt hanging down through the middle.
>
> The specimens were heated in a small portable forge, alongside the testing machine. The plates, with the bolts projecting upward, were placed on the fire, and the heat localized in the center over a diameter of about 6 inches, by keeping a small, bright fire, and dampening the outside with fine wet coal, to keep it from spreading.
>
> The characteristic failure of the bolts when screwed through and riveted over, was by the sheet bagging down, stretching out the threads to a bell-mouth shape, and shearing off a small annular ring representing the thickness of the riveting. It will be observed, when referring to specimens 1 to 4 and 15, that the edges of the head are very shallow where they are sheared off in line with the edge of the hole, and that the holes are stretched to such an extent that the threads lost their holding power. Generally speaking, the use of a nut increases the holding power of the staybolt over the plain riveting, when tested cold, about 100 per cent. and 50 per cent. when heated to a bright red.
>
> One of the most noticeable features shown in these tests is the comparatively slight decrease in holding power of any of the forms of crown stays until a temperature exceeding a black or dull red has been reached.



DIA. A	UPSET AT "B" TO
1"	1 5/32"
1 1/8"	1 9/32"
1 1/4"	1 13/32"

Firebox Crown Stays—F. J. Cole.



Diagrams Showing Results of Tests.

the nut will not pull off when overheated until the ultimate strength of the stay is nearly reached. It does not, however, offer so much resistance on the lower end against overheating as a button-head stay with enlarged end, and consequently is not in this respect as good or economical a design.

The sling stay shown in Fig. 4 is used for the first two or three rows. The upper hole is slotted to allow upward movement of the crown sheet to take place. This movement is caused by the expansion of the tube sheet.

The sling stay shown in Fig. 5 represents a neat and simple design with provision for expansion. It consists of only three pieces and allows ample freedom for the upward expansion of the firebox. It is in satisfactory use on the Chesapeake & Ohio and several other roads.

Another form of flexible sling stays for two or three rows in front is illustrated in Fig. 6. This bolt is easily applied and is one in which the adjustment does not depend upon the accuracy of marking off and drilling the pin holes as in Fig. 4. It is used by the Pennsylvania, the Chicago, Burlington & Quincy and other roads.

RECORD OF TESTS.

The average of all the tests, excepting those of lower temperature and of doubtful results, is as follows:

Specimen No.	Tensile Strength.		Remarks.
	Cold.	Hot.	
	Lbs.	Lbs.	
1	16 350	3,470	Head 1/8 inch above sheet, riveted just enough to make steamtight; head not to exceed 1 1/8 inches diameter.
2	16,700	3,473	Head 1/8 inch above sheet, riveted over.
3	17.600	4,040	Head 3/16 inch above sheet, riveted over
4	20,733	4,000	Head 1/4 inch above sheet, riveted over.
5	41,950	....	7/8-inch std. nut, tapped out to 1 inch, 12 threads, and riveted over, projects about 1/16 inch to 1/8 inch.
6	42,100	6.000	1-inch std nut, 12 threads, riveted over; projects about 1/16 inch to 1/8 inch.
7	38,120	7,095	Button head, 3/4 inch groove.
8	39,800	6,933	Button head, 13/16 inch groove.
9	.....	7,500	Button head, 7/8 inch groove
10	39,800	7,483	Button head, 15/16 inch groove.
11	39,800	8,766	Button head, no groove, countersunk
12	42,580	9,333	Button head, no groove, 3/16 inch copper washer.
13	43,100	10,150	Button head, with 1 1/16 inch reamed hole.
14	39,720	7.816	1-inch std. nut, 12 threads, nut countersunk [illegible] inch and well riveted over.
15	24,090	4 613	Screwed in sheet, 2 threads, rivet head 3/8 inch high and 1 1/2 inches diameter: largest head which can be formed.
16	40,300	9,730	Button head, with 1 1/4 inches tapered reamed hole, 3 inches thimble and nut.

Sizes of Crown Stays in Actual Use on Different Railroads and the Stresses per Square Inch of net Area.

Type of Boiler.	Dia, of Stay.		Area of Stay at Root of Thread.		Steam Pressure.	Spacing and Area Supported.	Pounds Supported by Each Stay.	Stress per Square Inch.		Remarks.
	Bottom.	Top.	Bottom.	Top.				Bottom.	Top.	
Belpaire..........	1 9/32	1 1/8	1.08	.812	190	4 25x 4.54	3,660	3,390	4,500	
"	1 9/32	1 1/8	1.08	.812	200	4 x 4.21	3,360	3,110	4,120	
"	1 13/32	1 1/4	1.32	1.024	210	4.625 x 4	3,880	2,935	3,830	
Wootten..........	1 9/32	1 1/8	1.08	.812	200	4 x 4 07	3,250	3,010	4,000	
Belpaire......	1 5/32	1	.863	.625	180	4 x 4.06	2,940	3,380	4 700	
Radial stay	1 9/32	1 1/8	1.08	.812	180	4 x 4.31	3,100	2,870	3,820	
"	1 8/32	1 1/8	1.08	.812	200	4.125 x 4.15	3,420	3,170	4,200	
Crown bar.......	1 1/8	1	.99	.55	180	4 x 4	2,880	2,920	5,230	
Radial stay	1 9/32	1 1/8	1.08	.812	180	4 x 4.31	3,100	2,865	3,820	
Belpaire..........	1 5/32	1	.863	.625	180	4.5 x 4.23	3,425	3,968	5 480	
Crown bar.......	1 1/16	1	.89	.55	165	4 5 x 5.25	3,898	4,380	7,087	
"	7/8	7/8	.42	.60	140	4.5 x 5.325	3,386	8,060	5,640	Changed, not in use
"	1 1/16	7/8	.716	.419	160	4.375 x 4.274	2,992	4,173	7,140	
Radial stay	1	1	.625	625	165	4.375 x 4.3	3,102	4,963	4,963	
" ...	1 3/32	1	.863	625	200	4.25 x 4	3,400	3,940	5,440	
"	1 3/16	1	.916	.625	200	4 x 4	3,200	3,490	5,120	
Crown bar.........	15/16	7/8	.419	.690	200	4 x 4	3,200	4,637	7,637	
"	1 1/8	1	.99	.55	200	4 x 3 7/8	3,100	3,130	5,636	

The screw crown stay shown in Fig. 3 represents one of the simplest forms in use. When properly riveted over in a countersunk nut it makes a secure stay and one in which

An improper and weak design of crown-bar bolt is shown in Fig. 7. It is inserted through the bar and screwed into the crown sheet from the top. A nut and copper washer on the under side provide means to render it steam tight. This form was used extensively some years ago, but is now superseded by bolts driven up from below (Fig. 8), with enlarged ends, fitted in reamed taper holes.

The form of crown bolt shown in Fig. 8 represents one of the best methods used in the construction of boilers, when the crown sheet is supported by bars. The lower end of the bolt is made about ⅛ inch larger than the body and turned with a taper of ¾ inch in 12 inches. The washers between the sheet and lower edge of the bars are usually made from 1½ to 3 inches in height. Each crown bar should be supported by two or four sling stays, according to the steam pressure to be carried and the size of the boiler.

Fig. 9 shows an arrangement of crown bars made in the form of rolled tees. In this construction the sling stays must be proportioned to carry the entire load, as the ends of the bars are not supported on the firebox side sheets.

Several years ago a large number of crown-bar boilers were built, for consolidation engines, in which the crown sheets were supported by ⅞-inch diameter bolts, screwed through the sheets and provided with nuts and copper washers in the firebox, the heads of the bolts being on top of the crown bars, arranged as shown in Fig. 7. They were spaced 5⅜ by 4½ inches, each bolt supporting an area of 24.18 square inches, the steam pressure was 140 pounds. Each bolt therefore sustained $24.18 \times 140 = 3,385$ pounds. Diameter at root of threads 10V = 0.731; area = 0.42. Stress per square inch = 8,060 pounds. When it is observed that the weakest part of these bolts was directly exposed to the fire, and to the chance of overheating—should the water be low—from any temporary cause, the very high stress will be more noticeable.

Area of Crown Bolts at Bottom of Thread (12 per inch) for Diameters from 1 to $1\frac{13}{32}$ Inches and Suggested Working Loads at the Upper and Lower Ends of Same for Radial Stay or Belpaire Boilers.

Diameter.		At Bottom of Thread.		Lower End.	Upper End.
	Decimal.	Diameter.	Area.	3,500 lbs. per sq. in.	5,000 lbs. per sq. in.
1	1.0	.892	.625	2,187	3,125
$1\frac{1}{32}$	1.031	.923	.669	2,341	3,345
$1\frac{1}{16}$	1.063	.955	.716	2,506	3,580
$1\frac{3}{32}$	1.094	.986	.763	2,670	3,815
$1\frac{1}{8}$	1.125	1 017	.812	2,842	4,060
$1\frac{5}{32}$	1.156	1.048	.863	3,020	4,315
$1\frac{3}{16}$	1.187	1.080	.916	3,206	4,580
$1\frac{7}{32}$	1.219	1.111	.969	3,391	4,845
$1\frac{1}{4}$	1.25	1.142	1.024	3,584	5,120
$1\frac{9}{32}$	1.281	1.173	1.080	3,780	5,400
$1\frac{5}{16}$	1.312	1.204	1 137	3,980	5,685
$1\frac{11}{32}$	1.344	1.236	1 199	4,196	5,995
$1\frac{3}{8}$	1.375	1.267	1.261	4,413	6,305
$1\frac{13}{32}$	1.406	1.298	1.323	4,630	6.615

These engines were in service for a number of years before any change was made in the crown staying. However, when these boilers were thoroughly repaired, the form of bolt shown in Fig. 8 was applied. This example may be regarded as the maximum stress which, perhaps, could be carried by bolts in connection with crown bars, rather than any form of through staying such as radial or straight Belpaire stays. It may be added that this style of staying and its very high stress, should be viewed as an interesting example of past practice rather than an instance of good design.

The decrease in the construction of crown-bar boilers in the last eight or ten years has been very marked. At the present time over 90 per cent. are built with some form of direct screw stays for the crown sheets. For high pressures of 200 pounds and over there is a distinct advantage in the use of screw-stays, from the fact that the safety of the boiler does not depend upon the proper adjustment of the sling stays between the bars and the shell, without which, crown bars for large boilers are insufficient to carry the entire load.

BOLSTER SPECIFICATIONS AND TESTS.

Among the improvements of recent years in the construction of wooden cars none is more important and far reaching than the introduction of steel bolsters. The advantages of what may be termed "modern bolsters" were so great when compared with former practice as to justify at their advent a certain amount of carelessness in selection of the type of bolster as long as the new one would greatly increase the capacity of the cars. This, however, is not now advisable.

The tendency has been to consider price as the determining element in selecting bolsters, but the differences in design are so great as to render this a relatively unimportant factor. It has in many cases been considered unnecessary to bother about the strength as long as the bolster manufacturers guaranteed the purchaser against failure. Since the first of the modern bolsters appeared the subject has received attention from those who understand and appreciate the stresses involved and also the importance of proper distribution of material with a view of making every pound of material count in terms of strength. It is evidently now necessary to take this fact, as well as price, into consideration in selecting bolsters and it would be better business policy to buy on a basis of strength, durability and price.

Admitting that several designs of bolsters may be depended upon to give good service, why not include in the specifications the limiting stresses per square inch in the tension and compression members and ask for bids on this basis? The design which keeps within the limits of the required stresses and has the minimum total weight could then be selected. These considerations coupled with the advantages in simplicity, durability, ability to go through wrecks without injury and price, would give the necessary information for intelligent comparison and all the bolster makers would be put upon the same basis. The question of the best distribution of metal could be answered and those bolsters which are systematically designed to carry the cars free from the side bearings would stand out prominently. This feature of bolsters does not appear to have been fully appreciated, and it is evident that if a bolster is designed with a view of separating the side bearings it must be very much heavier and consequently much more expensive to construct than one in which this feature is not provided.

The question of strength and allowable fiber stress in bolsters is an important one because of its bearing upon the weight of the structures, which must be hauled in trains. The stress should be as high as practicable because the higher it is the less material is required to make the bolsters, and yet the limit of safe strength for indefinite service must not be passed. The elaborate report on the design of axles before the Master Car Builders' Association in 1896 provides for 98.4 per cent. of the static load (in addition to the static load) as the maximum result of vertical and horizontal oscillations. This means that for an axle, double the static load should be provided for, but bolsters are not subjected to the rapidly alternating stresses of the axle and bolsters are also cushioned by the springs, which facts should be considered as effectively reducing the proportion of load due to shocks to perhaps 50 per cent. of the quiet load. This figure is merely estimated, but it serves to show that the subject of the strength of bolsters requires study in order to obtain all of the advantages offered by the use of metal in their construction.

A feature of bolster design about which very little is heard is transverse strength. This is exceedingly important in connection with the stopping of fully loaded cars of large capacity and that the stresses in this direction are great is not questioned. In fact, we believe that most of the bolsters which have failed have failed transversely. We are told that modern bolsters which have developed this weakness show a transverse strength of only from one-third to one-fifth of that of old wooden bolsters. There is plenty of room in the car structure to provide for these stresses, and the limit of transverse strength is that determined by the weight of the bolster.

From a brief consideration of these factors it seems clear that a great deal of thought may be profitably put into the design of bolsters.

Drop tests have been suggested and are now seriously considered as offering means for comparing bolsters. With this method it is possible to submit different specimens to the same conditions of test, but the objection raised is that this is not a service test under working conditions, and that a loading test from which fibre stresses could be ascertained would be a fairer method, which would give the kind of information desired. No one would consider submitting a draw span of a bridge to an impact test. It would be advantageous to submit a bolster to a heavy static load and then note the effect of a sudden increase of load of perhaps 50 or 60 per cent. of the static load, but if this cannot be done the method of gradually applied load and measurement of deflection seems to offer the best study of a bolster.

Consolidation Locomotive—Lake Shore & Michigan Southern Railway.

W. H. Marshall, *Superintendent Motive Power.* Brooks Locomotive Works, *Builders.*

CONSOLIDATION FREIGHT LOCOMOTIVES.

Lake Shore & Michigan Southern Railway.

One of 25 consolidation freight locomotives just completed by the Brooks Locomotive Works for the Lake Shore & Michigan Southern is illustrated by the accompanying engraving.

These locomotives are much more powerful than any previously built for this road, but they do not approach the weight and power of some of the designs for other roads which are not as favorably situated as to grades as the Lake Shore. They will haul as long trains as it is desirable to handle on this road, where extremely heavy freight locomotives are not needed. The cylinders are 21 by 30 inches, the driving wheels are 62 inches in diameter, and the weight on drivers is 149,000 pounds. At 85 per cent. of boiler pressure in the cylinders the tractive power is 36,000 pounds. The boiler is of the extended wagon top type, with the firebox above the frames. The heating surface is 2,686 square feet and the grate area 33.5 square feet.

The most interesting feature of the design is the care given to the details with the object of reducing the number of breakdowns on the road. The piston rods have enlarged ends, the axles throughout, including the truck axles, and the crank pins, have enlarged wheel fits, and the journals are large for an engine of this weight. All of the driving wheels are of cast steel. The driving wheel brakes are arranged in accordance with the plan illustrated on page 46 of this issue, the advantages of which are stated in connection with the description of the brake rigging of the fast passenger locomotives by the Brooks works for the same road. The following table summarizes the chief dimensions and particulars of the design:

Consolidation Freight Locomotive, L. S. & M. S. Railway.

Kind of fuel to be used	Bituminous coal
Weight on drivers	149,000 lbs.
Weight on trucks	19,000 lbs.
Weight, total	168,000 lbs.
Weight, tender, loaded	118,000 lbs.
Wheel base, total, of engine	25 ft. 6 in.
Wheel base, driving	17 ft. 4 in.
Wheel base, total, engine and tender	55 ft. 4¼ in.
Length over all, engine	41 ft. 5½ in.
Length over all, total, engine and tender	65 ft. 3 in.
Height, center of boiler above rails	9 ft. 2 in.
Height of stack above rails	14 ft. 10 in.
Heating surface, firebox and arch tubes	230 sq. ft.
Heating surface, tubes	2,452 sq. ft.
Heating surface, total	2,682 sq. ft.
Grate area	33.5 sq. ft.
Drivers, diameter	62 in.
Drivers, material of centers	Cast steel
Truck wheels, diameter	36 in.
Journals, driving axle, main	9½ in. by 12 in.
Journals, driving axle, main wheel fit	9¾ in.
Journals, driving axle, others	8½ in. by 12 in.
Journals, driving axle, others, wheel fit	9 in.
Journals, truck axle	6 in. by 12 in.
Journals, truck axle, wheel fit	6½ in.
Main crank pin, size	6½ in. by 6½ in.
Main coupling pin, size	7¼ in. by 4½ in.
Main pin, diameter wheel fit	7⅝ in.
Cylinders, diameter	21 in.
Piston, stroke	30 in.
Piston rod, diameter	3¾ in.
Main rod, length center to center	142½ in.
Steam ports, length	19 in.
Steam ports, width	1⅝ in.
Exhaust ports, length	19 in.
Exhaust ports, width	2¾ in.
Bridge, width	1⅝ in.
Valves, kind of	Allen, Richardson
Valves, greatest travel	5¾ in.
Valves, outside lap	1 in.
Valves, inside lap	None
Lead in full gear, forward	3/32 negative
Boiler, type of	Brooks improved extended wagon top
Boiler, working steam pressure	200 lbs.
Boiler, thickness of material in shell	⅝ in., 11/16 in., ¾ in., 9/16 in. ½ in.
Boiler, thickness of tube sheet	¾ in.
Boiler, diameter of barrel, front	64⅛ in.
Boiler, diameter of barrel at throat	76 in.
Boiler, diameter at back head	66 in.
Seams, kind of horizontal	Sextuple butt
Seams, kind of circumferential	Double and triple
Crown sheet, stayed with	Radial stays, with button heads
Dome diameter, inside	30 in.
Firebox, type	Over frames
Firebox, length	121 in.
Firebox, width	41 in.
Firebox, depth, front	80 in.
Firebox, depth, back	67 in.
Firebox, thickness of sheets	Tube, ⅝ in.; sides, back and top, ⅜ in.
Firebox, brick arch	On water tubes
Firebox, mud ring, width	Back, 3½ in.; sides, 4 in.; front, 4½ in.
Firebox, water space at top	Sides, 5 in.; front and back, 4½ in.
Grates, kind of	Cast-iron rocking
Tubes, number of	312
Tubes, material	Charcoal iron
Tubes, outside diameter	2 in.
Tubes, thickness	No. 11 B. W. G.
Tubes, length over tube sheets	15 ft. ¼ in.
Smoke box, diameter outside	67 in.
Smoke box, length from flue sheet	65 in.
Exhaust nozzle	Single
Exhaust nozzle, diameter	4⅞ in., 5 in., 5⅛ in.
Exhaust nozzle, distance of tip below center of boiler	2½ in.

Netting, wire or plate	Plate
Netting, size of mesh or perforation	3/16 by 1½ by ⅜ centers
Stack, straight or taper	Steel, taper
Stack, least diameter	15 in.
Stack, greatest diameter	16⅞ in.
Stack, height above smoke box	34½ in.

Tender.

Type	Eight-wheel, steel frame
Tank, type	"U" shape, with gravity slides
Tank, capacity for water	6,000 gal.
Tank, capacity for coal	12 tons
Type of under frame	Brooks 10-in. steel channel
Type of truck	Brooks 100,000 lbs.
Type of springs	Triplicate elliptic
Diameter of wheels	36 in.
Diameter and length of journals	5½ in. by 10 in.
Distance between centers of journals	5 ft. 6 in.
Diameter of wheel fit on axle	6⅞ in.
Diameter of center of axle	5⅞ in.
Length of tender over bumper beams	21 ft. 10½ in.
Length of tank, inside	20 ft. 4 in.
Width of tank, inside	9 ft. 10 in.
Height of tank, not including collar	5 ft. 0 in.
Type of draw gear	Brooks M. C. B. freight

Tender fitted with water scoop.

SOME CAUSES OF EXCESSIVE HEATING IN BEARING METALS.

Importance of the Microscope.

By Robert Job.

Chemist, Philadelphia & Reading Railway.

It is a fact well known to those who have made a study of bearing metals that physical condition and structure exert a marked influence upon the efficiency of the metal in service. Formerly great stress was laid upon the chemical composition of the alloy, and comparatively little attention was paid to the effects of the different conditions of foundry practice, or to the relation between structure and efficiency. The natural results followed, and "hot-boxes" became prevalent in railway practice, especially so when weights and speeds became materially increased. Attention was thus directed to the production of cool-running and durable bearings.

As a result of carefully conducted service tests, the old copper-tin alloy of seven to one was found to be inferior as a bearing metal, and the copper-tin-lead composition was gradually introduced, at first combined with phosphorus, and later with this element present in very small amount, if at all, and then used only as a deoxidizing agent. The efficiency of a copper-tin-lead composition, other things being equal, was shown by Dr. Dudley to increase with the proportion of lead which was present, the amount being limited owing to inability to combine more than about fifteen per cent. with copper to form a homogeneous composition. A large excess of lead was also avoided owing to the necessity of maintaining a strength sufficient to support the load, and also a fairly high melting point in order to prevent fusion and running from the box if heating resulted.

During the past few years greatly increased attention has been paid to the microscopic study of the metals, and the importance of this method of investigation is becoming clearly recognized in view of the results which are being obtained through its use. In the course of an investigation to determine the alloy most efficient for general railroad use, we found it desirable to follow up this structure of bearing metals in order to note the influence of this as well as that of the chemical composition upon durability in service.

In order to secure information, a large number of bearings which had run hot and had been removed from cars of different railroads while passing over the Philadelphia & Reading Rail-


Fig. 1.


Fig. 2.


Fig. 3.


Fig. 4.


Fig. 5.


Fig. 6.


Fig. 7.


Fig. 8.


Fig. 9.


Fig. 10.


Fig. 11.

way were taken for test. Fractures were made to show the general physical character of the composition, sections for microscopic examination were removed, polished, etched, magnified as far as necessary to show the structure to best advantage, and photographed. Analyses were also carried on at the same time, especially in cases where marked segregation of the metal was found to exist, in order to determine whether this result was due simply to an attempt at the foundry to form an alloy in proportions which were physically impracticable, or whether it was merely an effect of improper foundry manipulation. The marked crystallization which was often found in these bearings was also investigated in a similar manner. Also, in the majority of cases test sections were cut from the bearings, and the tensile strength and elongation determined, in order to find out whether in a given composition proper foundry practice would not be insured by placing a minimum limit upon the strength and ductility of the alloy.

Side by side with these tests a considerable number of alloys have been prepared in the foundry to check the accuracy of the deductions, and to secure information as to the conditions of foundry practice necessary to give the greatest strength and ductility to the given composition.

By means of this study it has been possible to determine the causes of excessive heating in the large majority of the bearings examined, and we may summarize them as follows:

First, Segregation of the metals.

Second, Coarse crystalline structure.

Third, Dross or oxidation products, and an excessive amount of enclosed gas in the metal.

In addition to these, the lack of proper lubrication might be mentioned, though our investigation seems to show that a relatively small percentage of the bearings examined had been discarded owing solely to this cause.

Segregation has been found to be due in many cases to an attempt to alloy the metals in improper proportions, this being notably the case in some of the copper-tin-lead compositions in which an excessive proportion of lead had been introduced, resulting in the liquation not merely of a portion of the lead, but often also that of a part of the copper into "copper-spots," thereby producing surfaces of relatively high heating capacity, and ultimately causing "hot-boxes." Figure 3 represents a photomicrograph of a copper-tin-lead composition which had segregated owing to pouring too rapidly when at too high a temperature. In this case a portion of the lead had separated out, and also a slight crystallization is seen owing to the presence of a slight excess of silicon in the metal. Figure 1 is a photograph showing upon one side the fracture of a badly segregated bearing with "copper spots," and upon the other that of a well-mixed and homogeneous composition—the segregation in the one case being due partly to the presence of an excessive amount of lead in the brass, and partly to improper foundry practice.

To a certain extent, these segregations may be prevented in a wrongly proportioned composition simply by a rapid chilling of the metal immediately after pouring, as for instance by the use of a cold iron mould. Such practice, however, is at the expense of the ductility of the metal, and causes a marked increase in brittleness with consequent rapid wear in service. High heating combined with rapid pouring and feeding is also a frequent cause of segregation, since under such conditions the metal in the mould remains for a considerable time in a molten condition, and by chilling gradually is given the greatest possible chance to solidify in definite natural alloys, throwing out whatever excess of metal may be present beyond these proportions, and thus resulting in segregation.

In actual service the effect of these segregations is readily understood, for it is evident that instead of an alloy of uniform hardness and heating capacity, there is a mixture, some portions of which are relatively very hard and others very soft, and this difference combined with that occasioned by the varying heating capacity of the different portions naturally localizes friction, and ultimately results in excessive heating. In a homogeneous alloy or composition no such conditions exist, and although, as is true of some compositions, some of the metals may be present, at least in part, in mere mechanical mixture and not as a definite alloy, yet the particles may be made so small by proper foundry practice that the friction throughout the bearing is practically uniform, and undue local heating is not liable to occur excepting through some outside agency.

The coarsely crystalline structure which was often seen in these defective bearings was in some cases found to be due to the composition of the alloy, antimony especially tending in this direction. In many cases, however, it has been traced to the foundry practice, often being due to rapid pouring at high temperature. Crystallization was also caused in some cases by the presence of an excess of various materials which were originally added as deoxidizing agents. Phosphorus and silicon are good examples. These, if added in suitable proportions, depending upon the condition of the metals, effect cleansing and free the metal from a large proportion of its enclosed gas, adding greatly to the fluidity, and thus rendering the casting less porous, and at the same time increasing strength and ductility often to a marked extent, correspondingly increasing the capacity for wear. Excess of these materials beyond the amount required for deoxidation appears not to be thrown off from the metal in the form of oxides very appreciably, but causes a crystallization which in a number of the bearings examined was so marked that it not only occasioned serious weakness and lack of ductility, but also such an increase in frictional qualities that cool running under the ordinary conditions of service was evidently an impossibility since the brasses had run hot and had been discarded from service shortly after the lead lining had been worn away. Figures 4 and 5 represent photomicrographs of two of these metals, and the structures show clearly the source of the heating.

One great advantage in the use of the microscope in connection with the deoxidation of these compositions lies in the fact that it becomes possible to tell quickly and with certainty the exact amount of the deoxidizer which is needed to combine with the oxygen present, without leaving more than a trace of the material behind in the finished casting to act as a weakener.

The effects of this coarse crystallization upon the durability of the bearing are two-fold. In the first place, increased local heating results in the same manner as in the case of segregated bearings, owing to the varying degrees of hardness and heating capacity of the constituents, and secondly, the ductility of the metal and the tensile strength are materially decreased. As the rapidity of wear with a given strength has been proved repeatedly by different experimenters to increase with the brittleness, it thus becomes evident that the durability of one of these crystallized bearings in service is bound to be defective owing to an excessive rate of wear, even though the heating which would naturally result should not occur.

Figure 10 represents a segregated copper-tin alloy containing about eighty per cent. of copper and about 0.1 per cent. of phosphorus, showing the crystalline structure of such composition, and it may be mentioned in passing that the old copper-tin alloy of seven to one, having a somewhat similar structure, and formerly much used for bearing metal, is a notoriously rapidly heating composition, and is not often found to-day in railway practice. Figure 2 is a photograph of the fracture of one of these badly crystallized brasses together with one showing a homogeneous and fine-grained structure.

Another very common source of difficulty found in defective bearings was the presence of particles of dross or oxidized metal mechanically enclosed, and also of large amounts of occluded gas in the metal. In the former case a hard cutting surface was presented to the journal, causing increased friction and hence heating. The presence of occluded gas in excess also tended in the same direction by reducing the actual bearing surface of the brass, and thus materially increasing the

pressure. Such metal was naturally found to be very brittle, and to have worn rapidly in service. In the foundry practice, the presence of this enclosed matter is as injurious as in the bearings themselves, tending to cause sluggish pouring, unless the metal is heated to a very high temperature, in which case crystallization and segregation—as shown above—are liable to result unless the speed of pouring is very carefully regulated.

Figures 6 and 7 represent dross mechanically enclosed in a copper-tin-lead composition, and Figures 8 and 9 show the appearance of the metal when containing an excess of occluded gas, and show clearly the loss of bearing surface which may result from such porous condition.

The presence of dross enclosed in a bearing is simply a proof of carelessness in the foundry and is due either to defective skimming or to pouring from the bottom of the pot. In either case proper oversight will prevent the difficulty. An excess of enclosed gas, on the other hand, is ordinarily due to lack of proper deoxidation of the metals, though at times it is also caused by pouring at too low a temperature. Thus it indicates not necessarily carelessness, but rather a lack of knowledge upon the part of the foundryman, of efficient foundry methods.

Figure 11 represents the structure of a copper-tin-lead composition, close-grained and homogeneous, showing only a slight crystallization, the brass having been deoxidized with a slight excess of phosphorus.

Turning now to the influence of the above-mentioned defects upon the tensile strength and elongation of the bearings examined, in every instance we have found the result which would be expected. The presence of dross or any foreign matter in the metal introduces an element of weakness, and thus reduces both the tensile strength and the elongation. Coarse crystallization produces the same result, the faces of the crystals forming the surface of least resistance, and thus facilitating fracture, and diminishing ductility. A test section taken from the bearing represented by Figure 5 showed a tensile strength of only 10,500 pounds per square inch with an elongation of only four per cent. in a 2-inch section. A bearing of the same composition if properly prepared in the foundry and free from crystallization would have a tensile strength of about 25,000 pounds per square inch and an elongation of about 13 per cent. when the test sections were taken from the bearing in a similar manner.

In the porous brasses we naturally found the same lack of strength and ductility owing to the deficiency in the amount of the metal present in a given section. For example, the bearing represented by Figure 8 showed a tensile strength of 15,000 pounds per square inch with an elongation of only six per cent. Figure 9 showed a tensile strength of 18,700 pounds per square inch, with seven per cent. elongation. Thus, we see that the influence of the various defects is clearly shown when metal of a known composition is subjected to the tensile tests, and it becomes possible to hold the foundry up to a high grade of excellence by means of these comparatively simple tests, with analytical and microscopic work as a basis.

Objection may perhaps be made that it appears rather arbitrary to place limits upon tensile strength and elongation in bearings, and that after all in practical service it is merely necessary to have, with a proper composition, a fairly strong homogeneous material, to obtain good results. In reply we will merely state that as a result of very carefully conducted service tests made by placing bearings of practically the same composition but differing widely in both tensile strength and elongation upon opposite ends of the same axles, we have invariably found that an increase of strength and ductility meant an increased life to the bearing in service and a lessening of wear, our results in this respect being in accordance with the deductions given by Dr. Dudley in 1892 before the Franklin Institute. As an instance of difference in efficiency due to these causes, we may cite a service test in which eight bearings each, of two copper-tin-lead compositions, were placed under tenders of fast passenger locomotives, one bearing of each kind being placed upon an end of each axle. All of the bearings were of practically the same composition, but the one set showed a tensile strength of about 16,500 pounds per square inch with an elongation of about six per cent., while the other had a strength of about 24,000 pounds per square inch with an elongation of about 13 per cent. This marked difference was due simply to the fact that in the one case the metal was porous, about as shown in Figure 8, while the other was thoroughly deoxidized, and was close grained and homogeneous, somewhat similar in structure to Figure 11. From time to time these bearings were removed and weighed, and the end-wear measured. As a final average result it was found that the more brittle set had worn thirty-five per cent. more rapidly than the other set. The results of similar tests also have been in line with these results. Therefore it becomes evident that increased ductility and strength in the bearing of given composition means, as stated, an increased life for the bearings in service, and as this increased ductility necessitates also freedom from the defects which we have mentioned above, it is evident that the chances of cool-running are proportionately increased. These qualities are therefore not merely of theoretical interest, but have also an intensely practical value, and have a marked influence upon the success and economy of railway service.

Regarding the preparation of the sections for microscopic study, we have found it desirable to cut them from the center of the bearing, filing and polishing after the usual methods, and finally etching with an approximately deci-normal solution of iodin in potassium iodide—the time of etching being usually about one minute. This etching gives very satisfactory results in many cases, although in some cases etching with dilute nitric or with dilute chromic acid has shown the structure to better advantage. In this much depends upon the information desired. In ordinary work we have found that magnification to about thirty diameters is sufficient to show the general structure to good advantage.

In connection with our work it is clearly indicated that too much stress can hardly be laid upon the importance of the microscopic study of these alloys owing to the definite knowledge which is given regarding not only the composition of the alloy, but the general physical structure, the presence or absence of friction producing agencies, and owing also to the check which is given over routine foundry practice.

GRATES FOR COKE BURNING.

In pursuing the subject of coke burning on locomotives to supplement the facts taken from the Boston & Maine practice (October issue), the most satisfactory information comes from Mr. J. S. Turner, Superintendent of Motive Power of the Fitchburg Railroad, who has been quietly working on this line for some months, and now uses coke in regular service without mixing it with soft coal, without using a steam jet under the grates and by making no changes except to get up a new cast-iron grate with a rather unusually large proportion of air openings. With this grate he has no difficulty in using all the coke that he can get, and whenever the coke supply gives out he uses coal on the same grates with equal facility. The increased air space appears to be beneficial also with coal.

The engraving of Mr. Turner's new grate shows no novel features. It is a box pattern which many will know as the Reagan pattern, although it is not the Reagan grate. The old finger grate is illustrated also, for convenient comparison. This grate will burn coke, but there was insufficient air space for good steaming. The grates have been very carefully calculated and the comparison is given here in full because of the general interest in the subject.

The comparison is based upon a 66 by 35-inch firebox on the Fitchburg locomotive No. 42, with a total area of 2,310 square inches. The areas in detail are as follows:

THE NEW BOX GRATE.

Total area of one grate	238.13 sq. in.
Open area	102.18 sq. in.
Closed area	135.95 sq. in.
Number of grates used	8.
Covered area of 8 grates	1,087.56 sq. in.
Covered area of side bars	198.00 sq. in.
Total covered area	1,285.56 sq. in.
Total open area	1,024.44 sq. in.

THE FINGER GRATE.

Number of end grates	2.
Number of intermediate grates	5
End bars, 2 in number	2½ in.
End bars, 2 in number	1¾ in.
Area of end bars	175.00 sq. in.
Area of side bars	231.00 sq. in.
Total area of end grates	310.00 sq. in.
Open area of end grates	151.24 sq. in.
Covered area of end grates	317.52 sq. in.
Total area intermediate grate	372.00 sq. in.
Open area intermediate grate	213.24 sq. in.
Total covered area intermediate grates	793.80 sq. in.
Total covered area in firebox	1,517.32 sq. in.
Total open area in firebox	792.68 sq. in.

COMPARISON.

	Box Grate.	Finger Grate.
Total area	2,310.00 sq. in.	2,310.00 sq. in.
Covered area	1,285.56 sq. in.	1,517.32 sq. in.
Open area	1,024.44 sq. in.	792.68 sq. in.
Per cent. open	44.35	34.32
Per cent covered	55.65	65.38

This exhibits an advantage of 10 per cent. of open area in favor of the box grate, the construction and support of which appears to be more favorable than that of the finger type. The open area is even then not nearly up to the practice in other branches of engineering, and it is perhaps possible to exceed these figures without reaching the practical limit. This example raises the question of the most advantageous proportions of air openings, which is a subject which is worth considerable study, but only on a stationary testing plant can figures be obtained that would be of value in guiding design.

Mr. Turner does not find it necessary to use water grates, and, as previously stated, they are not now fitted to Boston & Maine engines for this fuel. It should be stated here that the water grate illustrated in our October issue was an adaptation of a form the patent for which is held by the Hancock Inspirator Co.

Coke burning on the Baltimore & Ohio was taken up on account of the smoke problem, and it has been used with entire satisfaction for a number of years on that road, but the expense is greater than with coal. The grate arrangement is shown in the engraving.

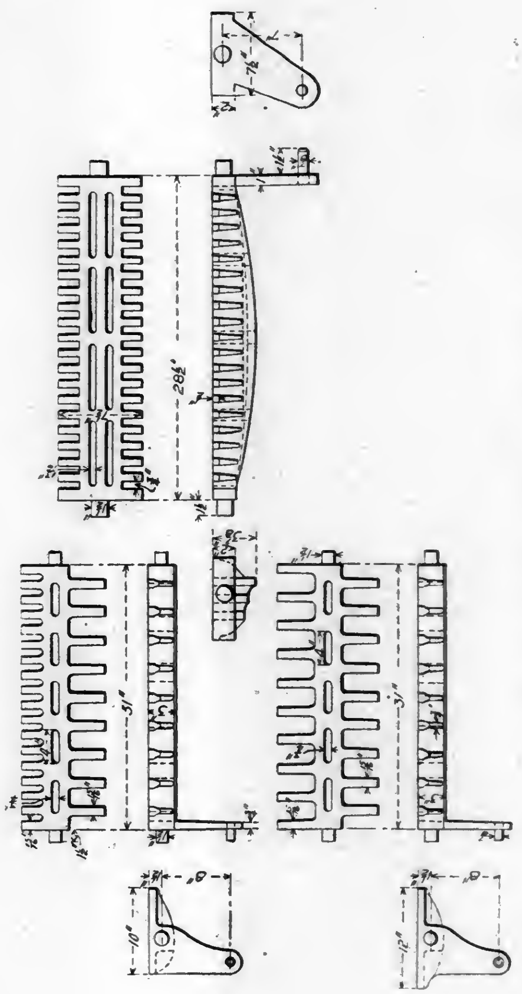
The coke used is the 24-hour lump coke from the Cumberland and Pittsburgh districts. At first considerable trouble was experienced from the formation of clinkers on the tube sheet, which gradually spread until the tube ends were nearly closed. A remedy was found in the use of bituminous coal mixed with the coke in the following proportions:

Length of run.	Coal.	Coke.
25 miles	8 per cent.	92 per cent.
50 miles	10 per cent.	90 per cent.
75 miles	12½ per cent.	87½ per cent.
100 miles	15 per cent.	85 per cent.
125 miles	17½ per cent.	82½ per cent.
150 miles	20 per cent.	80 per cent.
175 miles	22½ per cent.	73½ per cent.
200 miles	25 per cent.	75 per cent.

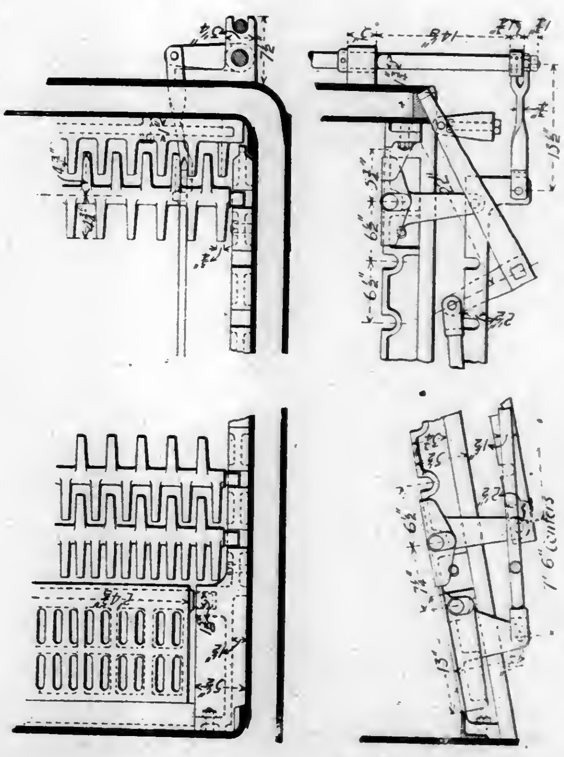
On this road it is customary to start the fires with coal, because coke does not kindle readily. After the coal fire has thoroughly ignited, the coke is introduced and a heavy fire is usually carried because the coke does not pack closely and cold air is passed up through the fire, which reduces the firebox temperature. A heavy fire prevents this.

It has sometimes been found advantageous to locate four or five air holes in the sides of the fireboxes, about 15 inches above the grates, in case the length of the firebox is greater than 10 feet. The brick arch is not used in coke burning engines on the B. & O. It interferes with getting the proper depth of fire. As a result of an extended experience, it has been found that coke is more injurious to steel fireboxes than was the case with coal.

While on the subject of grates for coke burning, it may be interesting to know that on the Alley Elevated, in Chicago, the engines at first burned coke exclusively, and for several months a number of engines were kept at work for 24 hours a day. They were of the ordinary finger type and of cast-iron. A hard coating formed on the tube sheet, but it was easily brushed off, and it was not serious enough to necessitate the admixture of soft coal.



Box and Finger Grates, Fitchburg R. R.



Grates Used with Coke Baltimore & Ohio R. R.

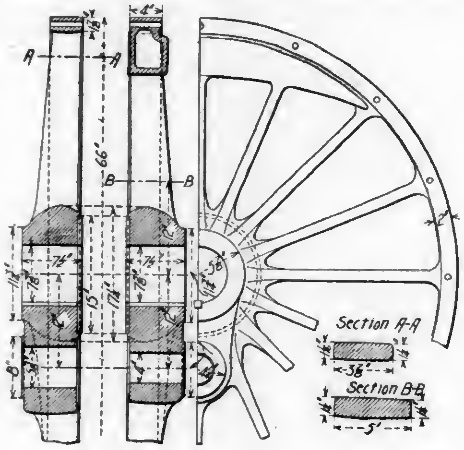


Fig. 1.

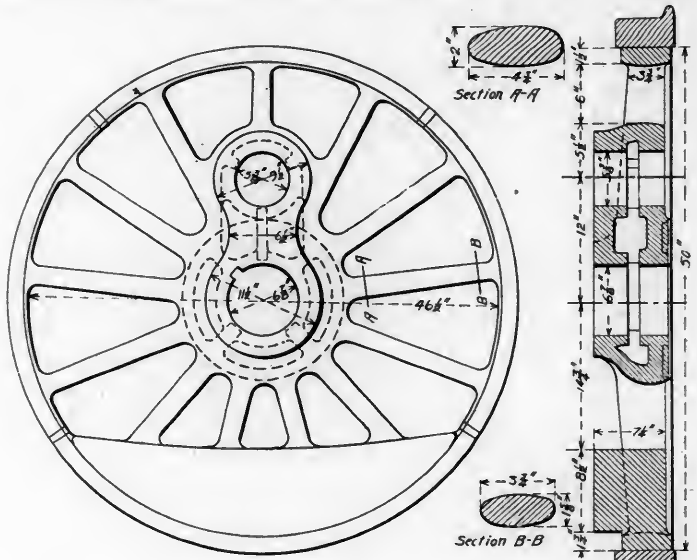


Fig. 2.

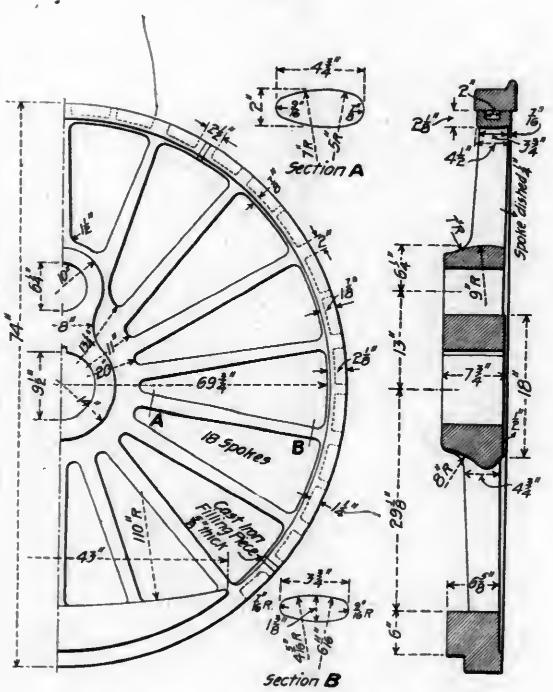


Fig. 3.—Fast Passenger, C. & N. W. Ry.

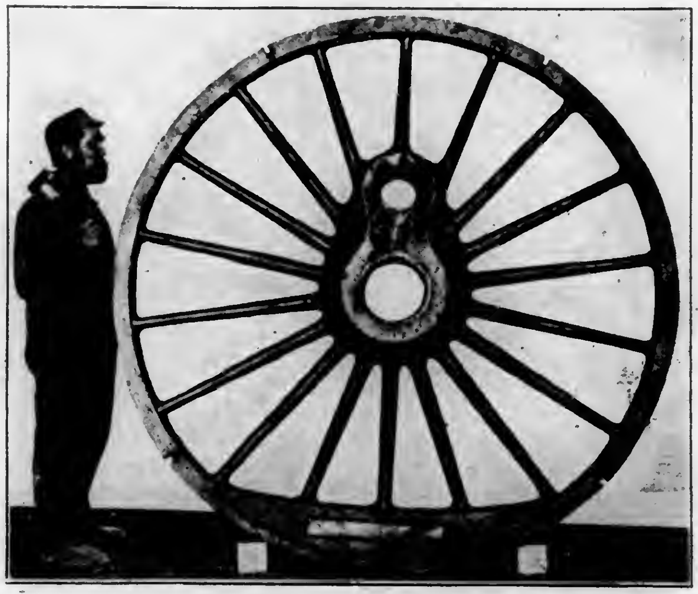


Fig. 4.—Same as Fig. 3.

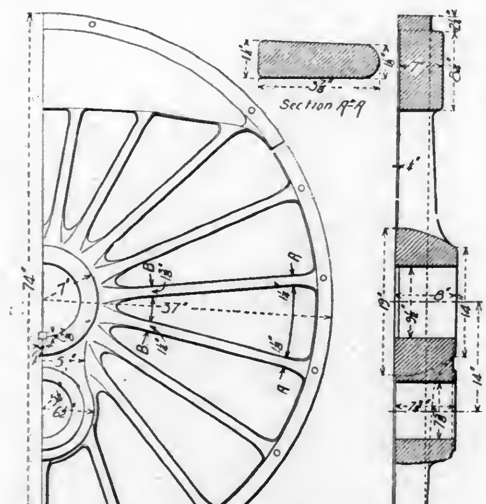


Fig. 5.—Lake Shore Passenger, Main Wheel.

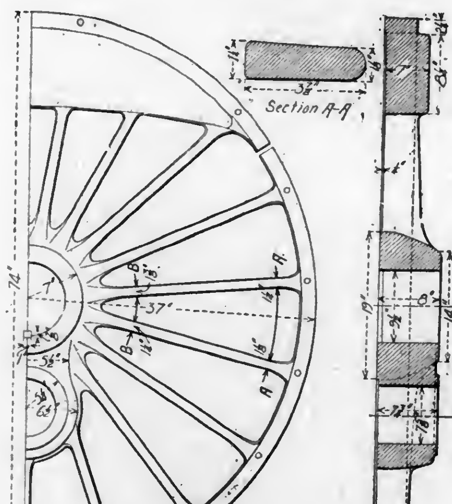


Fig. 6.—Lake Shore Passenger Front and Rear Wheels.

CAST STEEL DRIVING WHEELS.

This collection of information concerning various designs of locomotive driving wheels resulted from a consultation with a motive power officer who sought information with reference to the lightest structures which it is advisable to use for both passenger and freight service. An inquiry developed differences of opinion as shown by the drawings, and it was discovered that some people have actually ordered cast steel wheels made from patterns which had previously been used for cast iron wheels. Comment on this practice is unnecessary. There is no locomotive detail in which so much weight is to be saved by the use of cast steel as in driving wheels. It is specially important to save the weight of these parts because they are not cushioned by the springs and are more destructive to the track than the parts which are carried above the springs. The possibilities of light construction selected from successful and accepted practice are indicated in these examples.

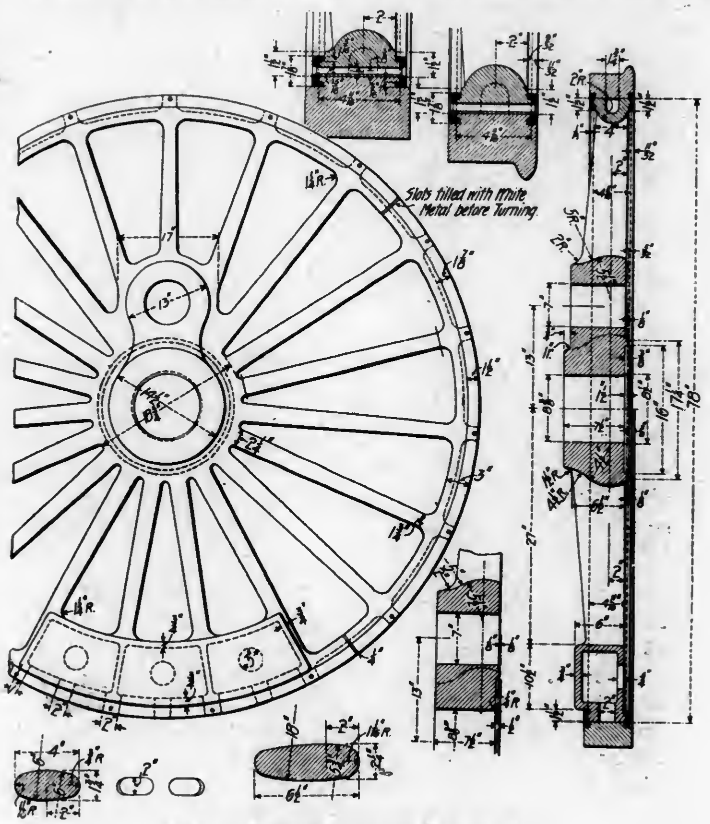


Fig. 7.—Fast Mail, C. B. & Q. R. R.

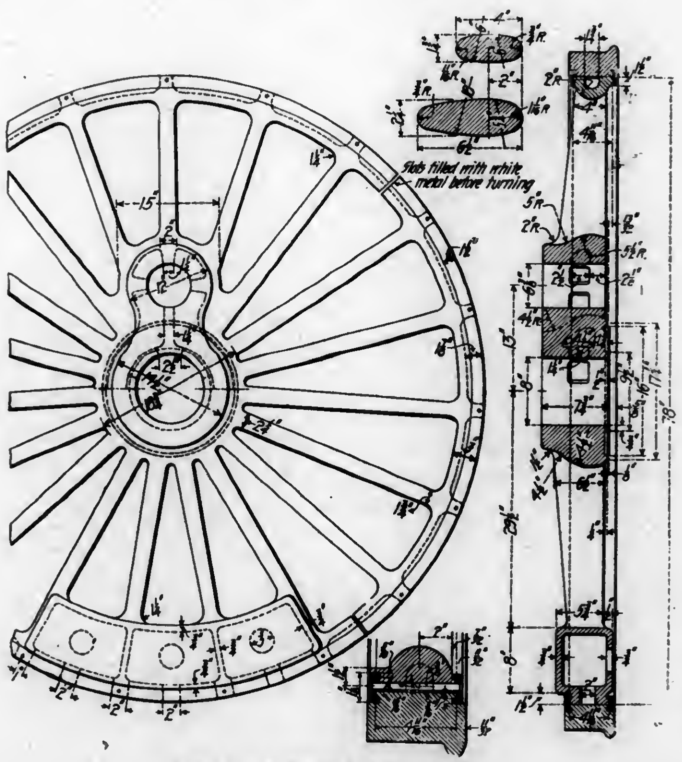


Fig. 8.—French State Railway.

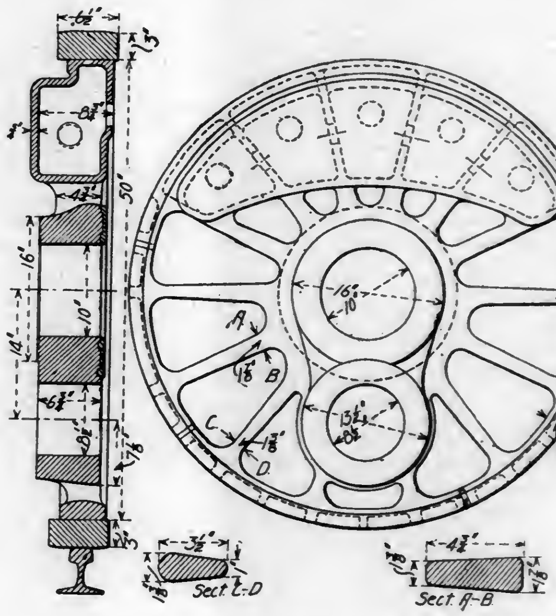


Fig. 9.—Recent Heavy Consolidation.

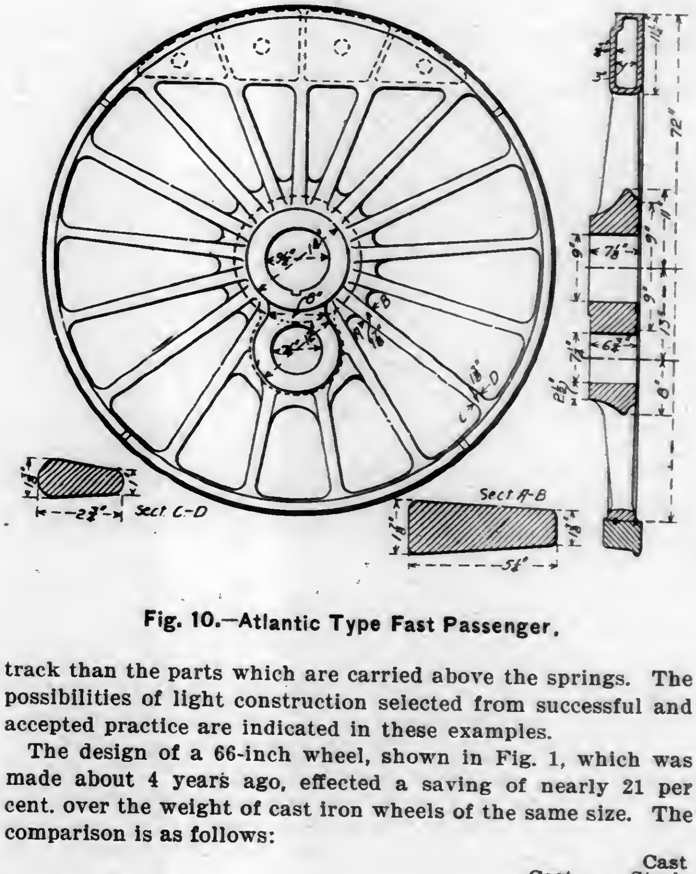


Fig. 10.—Atlantic Type Fast Passenger.

The design of a 66-inch wheel, shown in Fig. 1, which was made about 4 years ago, effected a saving of nearly 21 per cent. over the weight of cast iron wheels of the same size. The comparison is as follows:

2 66-inch centers.	Cast Iron. Lbs.	Cast Steel. Fig. 1. Lbs.
Front	5,080	3,156
Back	4,780	3,124
Add lead for counter balance	.....	1,520
Total	9,860	7,800
Saving in weight		20.9 per cent.

These cast iron wheels had the counterweights cast solid.

In freight wheels with smaller diameters, the advantage is less if the counterweights are of lead. The following table gives comparisons of 56-inch wheels, representing 10-wheel engines with the counterbalance weights cast solid, and another design with lead balance weights. In the case of the lead weights the advantage is less than 1 per cent., but these cast steel wheels are probably much heavier than safety requires.

Wheel Centers With Counterweights Cast In.

	Cast iron.	Cast steel.	Saving in Weight %
Two 56-inch centers, front.........	3,300 lbs.	2,640 lbs.	
Two 56-inch centers, main.........	3,700 lbs.	3,097 lbs.	
Two 56-inch centers, back.........	3,300 lbs.	2,783 lbs.	
Total weight....................	10,300 lbs.	8,520 lbs.	17.28%

Wheel Centers with Lead Counterweights.

	Cast iron.	Cast steel.	Saving in Weight %
Two 56-inch centers, front.........	3,260 lbs.	2,773 lbs.	
Two 56-inch centers, main.........	3,568 lbs.	2,956 lbs.	
Two 56-inch centers, back.........	3,260 lbs.	2,798 lbs.	
Total weight....................	10,088 lbs.	8,527 lbs.	
Add lead for balance weights.....		1,475 lbs	
Total weight....................		10,002 lbs.	.00852%

A 50-inch freight wheel is shown in Fig. 2. This is the last wheel in the list of seven given in the table below, and it represents a saving of 28 per cent. The section of the spokes is elliptical in this case. This design also was made about four years ago.

Finished Weights of Driving Wheel Centers.

Size.	Cast steel.	Cast iron.	Difference.	Saving.
66-inch............	1,834 lbs.	2,360 lbs.	526 lbs.	22.3 per cent.
52-inch............	1,646 lbs.	2,139 lbs.	493 lbs.	23.1 per cent.
52-inch............	1,637 lbs.	2,150 lbs.	513 lbs.	24 per cent.
50-inch............	1,617 lbs.	2,126 lbs.	509 lbs.	24 per cent.
56-inch............	1,510 lbs.	2,020 lbs.	510 lbs.	25.3 per cent.
56-inch............	1,312 lbs.	1,902 lbs.	590 lbs.	31.1 per cent.
50-inch............	1,288 lbs.	1,797 lbs.	509 lbs.	28.4 per cent.

The wheel shown in Figs. 3 and 4 was designed by the Schenectady Locomotive Works for the Chicago & Northwestern fast mail engines, illustrated in this journal in June, 1899, page 189. The center is 74 inches in diameter and the wheel is 80 inches, over the tire. The weights of the center castings in the rough were 2,461 pounds for the main wheel, and 2,350 pounds for the rear wheel, the finished weights are probably about 8 per cent. less, or 2,264 and 2,162 pounds, respectively. This is a very light wheel; it has 19 spokes of elliptical section. Another design of the same diameter, but with spokes of different shape, is shown in Fig. 5. This drawing represents the main wheel of the Brooks Lake Shore 10-wheel passenger engines, shown on page 344 of the November, 1899, issue of this journal. The weights of these castings in the rough were 2,850 pounds for the main and 2,346 pounds each for the front and rear wheels. The finished weights are 2,670 for each main wheel and 2,175 pounds for each of the others. The front and rear wheels are illustrated in Fig. 6.

Fig. 7 shows the 84-inch wheels with 78-inch centers for the Baldwin compound Atlantic type fast passenger engines for the Chicago, Burlington & Quincy, illustrated on page 141 of the issue of May, 1899. These wheels were made by the Standard Steel Works. A similar wheel for simple and compound engines by the same builders for the French State Railways is shown in Fig. 8. The weights of the centers for the Burlington wheels which are the same for Columbia and Atlantic type engines on that road are 2,882 pounds for the forward wheels and 2,990 pounds for the rear or main wheels, these are finished weights. The spokes of these wheels are 2¼ by 6½ inches at the hub and 1¾ by 4 inches at the rim. The rim is 3 inches thick and lightened between spokes. The wheels for the French engines have the same sections of spokes but are different in weight, the hubs of the French wheels being lighter. Some of the French engines are compound and some are single expansion. The drawing, Fig. 8, shows one of the drivers of the compounds. The weights for the compounds are 2,705 pounds for the main and 2,682 pounds for the rear wheel; for the single expansion engine they are 2,705 for the main and 2,995 for the rear wheel. The hubs of these wheels and the crank pin bosses are cored out for the purpose of lightening them.

An example of recent practice in 50-inch cast steel wheel centers for heavy consolidation engines is shown in Fig. 9. This is a main wheel, the center of which weighs 1,501 pounds in the rough, the front and rear wheel centers weigh 1,335 pounds, and the intermediate, 1,348 pounds. The finished weights are probably about 125 pounds less than these figures.

Fig. 10 illustrates the wheel center of a well-known Atlantic type passenger locomotive which has made a reputation for fast running. The main center, shown in the engraving, weighs 1,993 pounds, while the front center weighs 1,888 pounds. An allowance of about 150 pounds per center should be made for finishing. In Figs. 9 and 10 the hubs are lined with phosphor-bronze, cast in place, for which purpose two dove-tailed grooves are turned in the faces of the hubs. This proves satisfactory for new wheels, but to facilitate repairs it is found to be better to place the bronze liner on the box, which is easier to handle in the shop in making repairs than are the driving wheels.

Cast steel driving wheels made by the Sargent Company in 1897 for the Illinois Central R. R., with 72-inch centers, weighed 2,391 pounds each, and the physical characteristics were:

Tensile strength per square inch............................	63,400 lbs.
Elongation in 2 inches..	38½ %
Reduction in area..	47 %

The wheels shown in Figs. 3, 4, 5 and 6 were made by the Pratt & Letchworth Co. of Buffalo. Those for the Chicago & Northwestern were required to have not less than 60,000 pounds tensile strength and an elongation of not less than 15 per cent. in 8 inches. The writer has had the privilege of examining the records of forty reports of tests on cast steel driving wheels made by this firm for the Chicago & Northwestern to these specifications, and the tensile strength runs from 60,480 pounds with an elongation of 25 per cent. in 8 inches to 78,900 pounds and 17 per cent. elongation. The opinion of this firm, based on extensive experience, is that the best wheels are those in which the tensile strength is not high and the elongation is good. The presence of too much carbon has a tendency to increase the tensile strength and reduce the elongation. Steel of 60,000 pounds tensile strength and 15 per cent. elongation as specified by this road is strongly advocated.

The writer recently saw a cast steel driving wheel at one of the leading locomotive works which had been rejected by the inspector on suspicion because of some surface imperfections. The wheel had been "tested" under the drop until it was bent and twisted into unrecognizable shape, but without a sign of breakage. It was of the best of material, and "better than it looked." This brings up the question of testing cast steel for wheels, and it is a difficult one. It is evident that allowance should be made for the fact that the coupon, on account of its size, does not correctly represent the true character of the metal contained in the wheel. Being smaller than the wheels, there is of course a possibility of shrinkage in these castings and they cool more rapidly than the body of the wheel, which gives the coupon a structure different from that of the wheel, and it is believed, a somewhat inferior one. It has been learned from experience that test bars frequently represent a much lower standard than is shown by a similar sized piece cut from a spoke or the rim of a wheel.

A driving wheel is a difficult casting because of the danger of shrinkage stresses between the large and small masses of metal. The castings may never be entirely free from shrinkage stresses, but the fact that driving wheels of this material are so satisfactory reflects great care and skill in the furnace and foundry. The time is at hand for the use of cast steel exclusively for driving wheels.

LOCOMOTIVE TENDERS.

By William Forsyth.

The contrast between the tenders on English and American locomotives in the past has been marked, and decidedly to the disadvantage of the latter. The English tender, built entirely of steel with large wheels, substantial draft gear with good workmanship and fine finish all over, is an object lesson which locomotive builders in this country have but recently observed. The average American tender is a crude affair, being really a tank car consisting of what is essentially a freight car with a water tank and coal box on top. Recently the tendency has been to follow the English practice, particularly with passenger engines, by making the tender a handsome and substantial structure, and in a few instances the English practice of using three pairs of wheels instead of two trucks, has been introduced with satisfactory results.

The large size of cylinders and boilers of modern locomotives makes it necessary to use a tender of large capacity both for coal and water. While the use of water scoops for tenders renders large water space unnecessary, this appliance is only used where there is a dense traffic, and the capacity of modern tenders may now be said to be 5,000 to 6,000 gallons of water and 8 to 10 tons of coal. The large consolidation engines now being built when cutting off at half stroke consume 4,000 gallons of water every 13 miles, and 5,000 gallons every 16 miles. When cutting off at three-quarter stroke a 4,000-gallon tank will furnish a supply for a run of only 8 miles; 5,000 gallons, 10 miles; 6,000 gallons, 12 miles, showing the necessity of tanks of large capacity if very frequent stops are to be avoided. Large tanks are also used to carry the train past a station where the water supply is poor, and to enable the engine to make sufficient mileage to reach a point where a better water supply can be obtained.

The advantages of six-wheel tenders for passenger engines are, the use of large wheels and the simplicity attending few parts making the construction under the tank frame easy of access for inspection. The reduction in the number of parts connected with an axle and pair of wheels is considerable, as it means two journal boxes with the bearings, lids and attachments, a brake beam with its shoes, lever and connections. The six-wheel tender also virtually disposes of all those parts which are essential to the truck frame. With six-wheel tenders the journals are much larger, 5 by 9 inches, and bearings and other fixtures more substantial, and the rate of wear much less, requiring less attention for repairs.

The six-wheel tender is especially adapted to high-speed engines and has been used in this country without equalizers, and in the fastest service on roads where the track was not up to the best standard. The English tenders are not equalized as a rule and the only object of equalizers is to prevent derailment due to poor track. It is probable that the average condition of American main line track is equal to or better than the English track, and it is certainly better than the English track on which six-wheel tenders, without equalizers, ran for years with safety. On the fast runs where six-wheel tenders are most likely to be used, it is necessary for other reasons to have the quality of the track above the average. Equalizers introduce an additional set of details and for the reasons given above they are not considered necessary. With so few parts and such simple and substantial construction the cost of repairs must be much less than when trucks are used. When a water scoop is used there is more room for its mechanism than is the case with trucks. These are some of the principal advantages in favor of six-wheel tenders.

The high tractive power of modern locomotives renders it necessary to have a substantial draft gear on tenders, and where wooden underframes have not given way to iron or steel, the center sills at least should be steel, so as to secure a solid attachment for the draft gear. With the best practice the whole underframe is now made of steel channels—thus securing a stronger structure and requiring much less expenditure for repairs than a wooden frame. The fear of deterioration by corrosion for a long time prevented the more general use of steel underframes for tenders, but the general use of steel cars at present points to the fact that if steel can be used for freight-car underframes without fear of rapid corrosion it can certainly be used for tenders where the superior strength of steel is especially necessary.

With the demand for more coal space the shape of the flaring coal side above the water space has been changed, and in the large tenders the outside sheets are carried up vertically, making a plainer outline. The extreme width of tenders is now so great that the clearance limits are almost reached by the vertical side sheets and the inclined coal side is no longer possible or desirable. It is, of course, not necessary to carry this coal side around the back part of the tender, occupied by the manhole, and this part may be stopped off by a back board and left entirely clear, without any side beyond the water space, and this form of construction has appeared on recent tenders. It is necessary to place a guard rail of some kind about the manhole to prevent firemen from slipping off, but this is secured in a much simpler and cheaper way by the use of round iron rails than by the use of the sheet skirt at the sides and ends. The use of the latter only results in the accumulation of trash on the back of the tender, which soon gets mixed up with coal and water, and often becomes frozen; it is always a useless dead load, which, to say the least, is untidy. When this space about the manhole is clear and exposed to sight it can be kept neat and clean.

The use of oblong manholes for tenders is becoming general, as their use renders it unnecessary to make a water tank stop at an exact spot, but some margin is allowed in each direction.

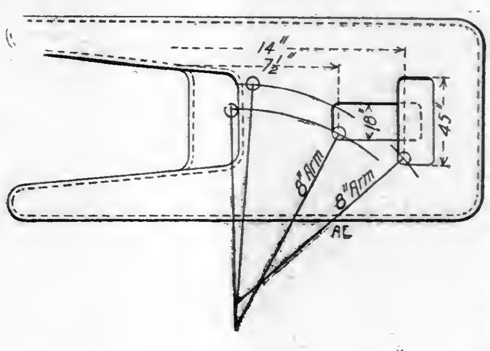


Fig. 1.

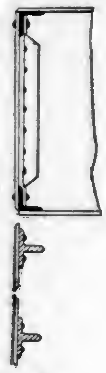


Fig. 2.

It was at first thought by some that this advantage could be best secured by placing the long axis of the manhole parallel with the track, and some tenders were built in this way, but it soon became evident that a larger range could be obtained by placing the long axis crosswise of the track, and this location is now always used where the oblong fixture is introduced (see Fig. 1).

The old method of bracing tanks was crude and flimsy, requiring frequent renewals and repairs. It consisted of cross-bracing about the center of the height of the water leg—using round bars or flat strips with pin connections and crow-feet or angles on the sides. The small section of the parts made them deteriorate rapidly by corrosion and wear, due to constant rattling of loose joints. With large tanks and high sides a much better and simpler form of bracing is now used. One of the best is the use of vertical pieces of heavy tee iron about 3 by 3½ inches thick, spaced about every 2 feet and bearing at the ends on the angle irons at the corners (see Fig. 2).

Tender trucks have been developed and improved to a remarkable degree, diamond freight trucks being no longer considered the proper thing for such an important service. The Fox truck, of ordinary freight types, has been used to some extent, but that company has designed a pressed steel truck

with elliptic springs and swing bolster which is more suitable for the purpose. As it is often necessary for the fireman to stand on the tender while firing, the springs should have an easy motion. It is doubtless true that such heavy loads are carried on elliptic springs with less injury to the track and less wear to the truck and tender frame. The old practice was to have side bearings on the rear trucks and none on the front trucks, leaving the whole load on the front truck to balance on the center plate; but with larger and heavier tenders it has been found necessary to steady the load, and it is now the usual practice to place side bearings on both front and rear trucks.

The adjustment of the height of the rear drawbar and front platform on tenders to different heights of driving wheels was formerly accomplished in a crude and troublesome manner. When new tires or larger drivers were put in, the tender frame was blocked up on the truck in order to get the fireman's platform to the proper height. It was then necessary to let down the rear draft iron or put on a new one of a different pattern, but the use of M. C. B. couplers on tenders has rendered this method undesirable and the tender frame is now maintained at a standard height from the rail and the front platform is changed to suit the height of the drivers. The usual design, for connection between engine and tender, does not admit of adjustment to suit changes in the thickness of tires or diameter of drivers, and there is an opportunity here for an improvement in the front tender draft iron which will so arrange it that it will admit of adjustment of the height of the front draw-bar.

Tender steps and grab handles have also been rather crude in the past, but the use of cast iron steps, with a wide one at the bottom somewhat offset, is now growing more general. This form of tender step was recommended by a Master Mechanics' Association committee, and is illustrated in the proceedings for 1896, page 311, and it is there recommended that to insure safety the form and location of tender steps should be nearly uniform, so that one could in the dark readily locate with his feet and hands the steps and hand hold of any locomotive.

The use of large figures 2 or 3 feet high on the sides and ends of tenders was never justified by any considerations of utility or beauty, and they are gradually disappearing. It is seldom necessary to read the number of a locomotive at a distance of more than a hundred feet and figures 6 or 8 inches high can be easily read at that distance. The numbers on the cabs or sand boxes are also sufficient for most purposes, and the number on the side of a tender is almost if not entirely useless. Figures on the end of a tender 8 or 10 inches high should be sufficient to locate an engine in the round-house when the engine is placed head in—but it is proposed by some roads to leave the numbers off of tenders altogether, and by others to paint the numbers on removable tablets so that any tender of proper type can be attached to any locomotive. On the London & North Western a locomotive illustrated in the January number, page 1, it will be noticed that the only letters on the side of the whole locomotive is the engine number on cab, and there is no figure on tender. An example of a handsome six-wheel American tender is shown on page 22 of the January issue of this journal. This is the Pennsylvania fast passenger engine, Class E 1. The admirably designed location of the steps on each end of the tender and on the back of the engine will entirely satisfy the Master Mechanics' Association requirements already referred to. The coal space on this tender is arranged like that used on German engines, where the sloping coal deck extends clear across the tender, the front portion being level and about 18 inches above the top of the front sill. By this arrangement the coal is constantly delivered by sliding down the incline, to a point most convenient for the fireman.

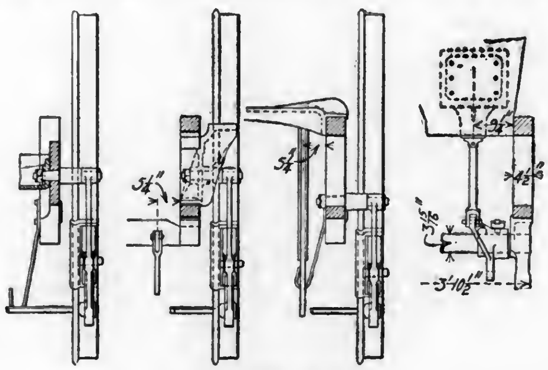
Another tender of exceedingly attractive appearance and good design is that on the new Brooks passenger engine for the Chicago and Alton road, which is illustrated in this issue. In this case the gangway is so narrow that one step casting at front of the tender is sufficient for the engine and tender. This tender is painted a maroon color to match the cars on the Alton day train from Chicago to St. Louis. The lettering and striping are especially neat and in striking contrast with the large ugly figures so often seen in Western tenders.

General plans and details of several modern American tenders will be illustrated in a future article as this portion of the locomotive is usually shown in outline or by photograph and it has not received the attention which its present importance and interest demands.

IMPROVEMENTS IN LOCOMOTIVE DRIVER BRAKES.

The publication of the improved design of locomotive driver brakes in the January issue of this journal has brought out correspondence which indicates that there is to be an improvement in the status of locomotive brakes as a factor to be considered in the original designs of locomotives, and it is beginning to be appreciated that the stopping of fast and heavy trains is one of the most important considerations in their operation.

It was natural that the driver brake should be a rather crude affair during its early life, and that it should be considered as an attachment rather than an integral part of the locomotive because at first it was applied to locomotives which were in service, but there is no reason for perpetuating the positively bad practice now prevalent. The driver brake has not held a prominent place in the minds of locomotive men during the drawing room stages of construction, but this is now rapidly being changed. Only recently has it become necessary to seriously consider the saving of weight in other parts in order to favor the boiler, but this influence is now very powerful, and is likely to effect the greatest improvements in locomotive development. This problem necessitates the most skillful work in connection with details, and one of



Transverse Sections.

the most promising sources of weight saving and weight adjustment is in the driver brakes.

The adjustment of weight whereby the center of gravity is carried as far forward as possible to the relief of the driving wheels is desirable, and this is carried out in designs by the Lake Shore & Michigan Southern for 10-wheel passenger engines, the Pennsylvania on Class H 6 consolidation and E 1, Atlantic type engines, and on the Baltimore & Ohio in 10-wheelers. In our December, 1899, issue the advantages of designing the frames for the direct connection of the brake rigging were clearly indicated. It is evident that if the brake cylinders are carried forward to a convenient location under the front end of the barrel of the boiler, still further advantages will be gained, and these are important enough to command the attention of those who are working on the lines mentioned.

If the brake cylinders are placed near the front of the engine a large proportion of their weight is carried upon the truck instead of being thrown entirely upon the driving wheels, as is the case with the usual location, near the rear ends of the frames. Unusual efforts are now being made to reduce the weight at the rear end of boilers by tapering the sheets and inclining the back heads. There is a further advantage in the forward location of the cylinders because it permits of placing the brake shoes against the rear instead of the front of the driving wheels. Furthermore, the cylinders should be kept away from the firebox in order to avoid the troublesome burning out of the piston packing. All of these recommendations and the retention of the push principle with the absence of stuffing boxes on the brake cylinders are offered by the forward location. It may also be urged that

the cylinders are not liable to injury in derailments or other accidents if they are placed under the front end of the boiler, or, as in the case of the new Lake Shore 10-wheel passenger engines.

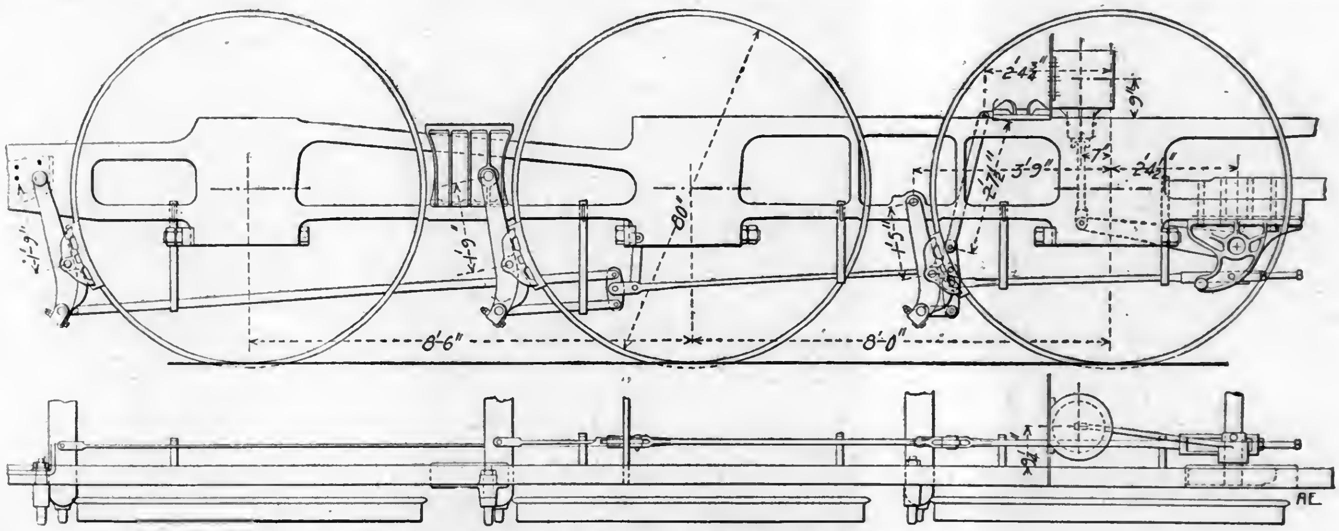
In the present light on the subject, the practice of placing the brake shoes back of the wheels seems to be a great improvement. This plan causes the brakes to press the driving boxes against the shoes, instead of against the wedges, and it gives an upward thrust instead of a downward pull of the shoes upon the hangers. This relieves the springs, and spring hangers form a serious additional load, and these parts may be materially lightened if they are not subjected to it. Spring hangers are subjected to particularly severe service, and Mr. F. J. Cole (issue of May, 1899, page 145) states that even for exceptionally good iron the fiber stress of these parts should never exceed 4,500 pounds per square inch if failures and breakdowns are to be prevented. The stresses due to the application of the brakes undoubtedly play an important part in the life of these hangers, and it seems probable that this influence, in the case of designs with the shoes in front of the wheels, accounts for the very low allowable working stresses.

The accompanying engraving illustrates the brake rigging on the 10-wheel passenger locomotives built by the Brooks Locomotive Works for the Lake Shore, already referred to. It will be noted that the frames, frame braces and boiler supports are used as far as possible for connecting the brake fixtures, necessitating very few additional parts for the attachment of this rigging. This design is an example of excellent practice, but it is evident that it can be improved by a further application of the Higham method of attachment to parts forged upon the frames for the purpose.

It is difficult to locate a push cylinder applied to a 10-wheel locomotive properly unless placed toward the front of the engine without using a long connection between the piston rod and the brake lever, and the parts must be made very heavy to avoid buckling. In a locomotive of this type with large driving wheels, say 78 inches in diameter, it is very difficult to find a place of attachment in the rear of the drivers in the usual manner, so that it may be said that the construction of large 10-wheel locomotives makes the new plan very desirable also from a constructive point of view.

It is exceedingly important to locate the brake shoes as high upon the wheels as possible, and if practicable it would be very desirable to place them opposite the horizontal centers of the wheels. This applies to cars as well as to locomotives. The lack of room between driving wheels renders it necessary to drop the shoes too low in many cases, and the effect of this is probably not fully appreciated. If it were, greater efforts would be made to give the proper amount of room for the shoes. The chief trouble comes from the vertical motion of the engine on the springs which causes the shoes to rise and fall in relation to the wheels. This changes the piston travel and seriously interferes with the efficiency of the brakes, and its effect is of course greater, as the position of the shoes is made lower because the horizontal movements of the shoes are greater than when placed opposite the centers of the wheels where they ought to be. The stroke of the cylinder piston should be kept as short as possible for the sake of economy in the use of air, especially because of the increasing demand for air for purposes other than the operation of brakes. "Air brake parasites" is an apt term for a number of uses of air in trains with which the air brakes have nothing whatever to do, and the question now is how to get enough air for the brakes. Air power is used for bell ringers, sanders, raising water in sleepers, making gas for car lighting (Frost system), running ventilating fans, shaking grates, operating blow-off cocks, pilot couplers and flangers, and opening firebox doors, not to mention all the applications now in use. This is severe on the air brake, especially if it is not safe-guarded against the wastefulness of long piston travel.

An illustration showing the importance of putting the brake shoes high up on the wheels was seen some time ago when a stock train came into a terminal and discharged its load. The engine which had hauled it over the division when loaded could not start the empty train out of the yard. This was because the adjustment of the shoes was close and the shoes were low on the wheels. The relief of the load raised the cars on their springs enough to bring the brake shoes against the wheels and hold them as if they were under pressure from the cylinders. This requires attention in the design of cars and locomotives. It cannot be remedied after construction.



A Good Example of Driving Wheel Brake Rigging.
New Ten-Wheel Passenger Locomotives—L. S. & M. S. Railway.

THE MASTER MECHANICS' AND MASTER CAR BUILDERS' CONVENTIONS FOR 1900.

The annual convention of the Master Car Builders' Association will be held at Saratoga, N. Y., commencing Monday, June 18, and the Master Mechanics' Convention will open Thursday, June 21, lasting through the week. The dates have been changed in order to bring the two conventions within one week. The Grand Union Hotel will be headquarters, the usual rates having been made for members of the Associations and their friends. The United States Hotel will be open and those desiring dignified comfort and quiet will be glad to avail themselves of the opportunity of stopping there.

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Special Notice.—*As the* AMERICAN ENGINEER AND RAILROAD JOURNAL *is printed and ready for mailing on the last day of the month, correspondence, advertisements, etc., intended for insertion must be received not later than the 20th day of each month.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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The brief note entitled Master Mechanics Wanted, on page 16 of our January issue, resulted in filling the positions referred to, and in bringing out a number of promising men whose names are on file in our editorial rooms for the benefit of inquirers who need assistants.

A number of railroads are seeking good men for responsible motive power positions, and we have been repeatedly solicited for names for these positions. There are many capable young men who are not well known and we cheerfully accept the task of bringing competent and reliable men before the higher officers who inquire. See page XVI, this issue.

In another column Mr. Squire suggests a practical study of the movements of the sheets of a locomotive firebox for the benefit of knowing how the stresses due to expansion and contraction act. Actual measurement of the movements of the sheets would throw light on a very obscure subject, and it is to be hoped that the suggestion will be carried out. Our correspondent presents the subject in a most satisfactory way, which includes a sketch from which the recording device may be made. It ought to be applied to fireboxes of various forms, to those which are long and deep, those which are shallow and short, and, in fact, to all kinds of stayed fireboxes. The form used on the Lehigh Valley and recommended by Mr. F. F. Gaines, on page 9 of our January issue, may be expected to give favorable results. This is now largely a matter of opinion, but a few simple experiments will show which is the best form. This subject is important enough for a thorough investigation by the Master Mechanics' Association.

The increasing weights of passenger trains and the increasing severity of service are becoming burdensome to those who are responsible for the designs of locomotives to handle them. While there may be, and probably are, economical advantages in the use of the most powerful locomotives, it is a question whether some of the present pressure should not be applied to other questions such as the provision of interlocking plants at all crossings covered by fast runs and in the improvement of locomotive water stations. In a remarkably fast run recently recorded in these pages, two crossing stops are noticed. The effect of these stops on fast trains is easy to comprehend and it seems equally clear that the expense of stopping all trains at such points should be appreciated. The engineering department is often behind in the strength of bridges to carry the engines which are now required and it seems appropriate to direct attention also to the non-interlocked crossings as one factor in the present necessity for heavy engines.

The struggle for a proper solution of the trouble over the status of the engineer in the navy is far from being ended. The line officers have won their case and the engines are now—if we understand the situation—placed in the hands of enlisted men. The real purpose of the personnel law was to solve the difficulty by insuring that all line officers in future shall be engineers. This appears to have been very satisfactorily settled, but owing to a recent order issued by the Assistant Secretary of the Navy, the commissioned officers are relieved from engine room watch duty. The navy and the nation cannot but suffer for this, and yet it may require another war to right it. The lesson, learned at Santiago, by both Spain and the United States, that the success of a fleet of modern war vessels depends more upon the engineer than any other human factor, is lost if this law is not carried into effect, and we may expect to see Admiral Melville's ominous words on this point before the American Society of Mechanical Engineers come true. When the country awakens to the fact that the present status of the real engineer in our navy is exactly that of the Spanish in the late war something will be done.

The skein test for color blindness is known to be defective, yet it is probably used more than any other, and presumably through ignorance. Prof. Scripture and Dr. C. H. Williams gave most valuable information on this subject before the New York Railroad Club last November, and the complete discussion has now become available in the proceedings of that organization. Next to normal color vision, at least, if not first in importance, is the standardization of the colors, particularly of red and green. It is generally the custom to accept signal discs from glass manufacturers without tests of any kind, and in this discussion it was proved that many reds are used which are dangerous because they let the green through as well as the red. Every signal engineer or officer in charge of signals should use the spectroscope to guard against this dangerous glass. These instruments are inexpensive and are made in sizes convenient for the pocket. When one of these so-called red glasses is held before the instrument the green rays and part of the blue will appear always with the red. The correct red glass shuts off all rays except the red and these are seen distinctly. The good and dangerous reds are very similar in appearance, but one is red while the other is a mixture of red and green. A similar, but less dangerous, trouble occurs with green glass, some of the greens being distinctly blue.

The increasing weight of locomotives is strikingly shown in this issue by the table of comparison of the weights of locomotives built by the Brooks Locomotive Works in the years 1891 to 1899. These figures are from one building firm only, but it is believed that they fairly represent the practice of the eight years. The most striking figures given are for the average weight of engines and tenders in working order and the average weight of the engines alone. The former figure showed an increase of 85,783 pounds per locomotive and the latter an increase of 53,135 pounds. These figures are unexpectedly large and very significant, because they indicate corresponding advancement in power and improvement in operation. These statistics would astonish those who considered the limits of weight to have been reached years ago. There is no ground for prediction as to the weights of the future, but this increase carries the impression of the very great importance of making the weight count to the utmost in power capacity. Unless the increased weight is productive in this way it is of no value. What is now most needed is improvement in the making and the use of steam also in counterbalancing, so as to permit of using greater weights on driving wheels without increasing the destruction of rails.

SYSTEMS OF ELECTRIC DRIVING IN SHOPS.

The present indications are that during the next few years all new shops and many remodeled old ones will have some, if not all, of the machines driven by electric power. Long lines of shafting often require from 60 to 75 per cent. of the total power to overcome friction, and it is safe to count upon enough saving in power by the introduction of electric motors to furnish light for the same shops. The question of fuel economy, however, is not the most important one, because with wasteful systems the cost of power is usually about 2 per cent. of the cost of labor. The important question is to get the most out of the plant. The Baldwin Locomotive Works several years ago expended about $65,000 in electrical machines and the cost is saved every year in the saving of labor. The Chicago, Milwaukee & St. Paul Railway installed an electric motor to operate a turn-table. The cost was $550, and it saves $1,600 per year in wages.

Electric motors are accepted as offering valuable means for increased shop output; they are reliable, efficient and worthy of confidence; they are ready to respond instantly to a demand greatly in excess of their rated capacity, and they have the further advantage of accurate and easy adjustment of speed. It is not easy, however, to learn the best method of obtaining these advantages in practice. Each individual plant has its characteristics to be considered, and one of the limiting factors in the adoption of a plan of electric driving is the relative cost and efficiency of large and small motors. Seventy-five dollars per horse power for one-horse power motors and $20 per horse power for 50-horse power motors may be taken as an approximately correct proportion.

It is desirable to use as few different sizes of motors as possible because of the repairs. These considerations lead to the comparison of four systems of motor arrangement:

1. Individual motors.
2. The group system.
3. Comparatively long lines of shafting, each driven by its motor.
4. A combination of the individual and group systems.

Individual Motors.

Where the tools are relatively large this plan reduces the losses of transmission to a minimum and it also permits of any desired use of cranes and machinery for handling parts and finished work to and from the machines. It avoids all the troubles caused by belts, but the cost is high and the motors will seldom be of greater capacity than 5 horse power. The power of the motor must, of course, be sufficient for the greatest load ever put on the machine and for a large part of the time much less power is required, which means rather inefficient operation of the motors. This plan also requires a large number of different sizes of motors, for which extra repair parts must be kept, and with small motors the repairs are much greater in amount than with larger ones. This system, however, uses no power except when the machines are running, which is not true of any other system.

There is no system which permits of getting so much out of the machines as that of individual motors, and in some cases this will outweigh all other considerations. With a direct-connected motor it is possible to obtain more perfect speed control than can be had in any other way. The full capacity of the tool is always available at a movement of the hand and the machine may be started, stopped or reversed by the attendant without changing his position. Belt shifting is not difficult, but it is one of the little things that men will not do unless it is necessary, and a little hand switch to control the speed will be used when a belt would not be shifted.

Most tools are limited in capacity by the system of driving with which they were originally fitted, and the usual range of speeds is very small. This is the only system which offers this very desirable speed and power control for each machine, and it counts powerfully in the output of a shop where it can be used.

The Group System.

This plan recommends itself where the individual machines are not large enough for independent motors and where improved transmission without too large a capital outlay is sought. Shops and factories with no large tools and with large numbers of small-powered machines must necessarily come under this system. It does not do away with shafting, but it permits of cutting the shafting into convenient lengths and avoids what is probably the greatest difficulty with shafting, the friction of long lengths on account of their liability of getting out of line. The motor driving a group of machines does not need to have a capacity equal to the sum of the maximum possible demands of all of the machines, because it is safe to count upon some of them as being idle or requiring only a small amount of power. The electrical installation of the Baldwin Locomotive Works has the proportion of 1,300 horse power in the generators to 3,500 in the motors, and it seems to be sufficient, as the average horse power at the switchboard is but 1,000.

The groups may be arranged with a view of running certain of them overtime in order to keep up with the rest of the plant, and all of the machines required for certain overtime work would be put into that group. This system renders the selection of motors comparatively easy and has the advantage of requiring the minimum number of different sizes; two sizes, 15 and 25-horse-power motors will suffice for many large shops. The groups may be arranged to have a surplus of power in each at the start in order to provide for expansion. If the load eventually becomes too great for the smaller size, one of the larger ones can be substituted.

Motors on Long Line Shafts.

While a number of cases of this arrangement are in successful use, the objection to it is that there is little diminution in the belting, and, in fact, no advantage over the usual steam drive, except that the steam plant may be concentrated in one place for several buildings or departments. It is a great advance over the distribution of steam engines all over a plant, but it does not bring out the best possibilities of distribution of power by electric motors. Two motors may run a shop or department, one being at the center of each side of the building and connected each way by clutches to the shafting. This permits of running one-quarter of the shop alone, but it involves running long shafting and many idle belts in order to reach a few machines for overtime work. The cost of the motors is less, but their efficiency is not sure to be higher because of the lack of flexibility of the system. This plan does not accommodate good crane service.

Combined Individual and Group System.

By running the heaviest and largest machines by direct-connected motors, stopping at those requiring less than about

5 horse power, and grouping the smaller machines to motors of from 5 horse power up, a very satisfactory system may be devised. This is the one followed at the Baldwin Locomotive Works and in a number of large establishments. It is flexible enough for adaptation to all except extraordinary conditions.

Determination of Power Required.

The indicator affords the readiest and most reliable information concerning the amount of power required. In applying motors to an old shop the full load of the shop may be ascertained at the engine by indicating, and the sizes of the sections or groups may be determined by cutting off portions of the shop successively at the shaft couplings. This will probably be necessary for each individual case, particularly where the groups involve much belting and shafting. For electric drives in new shops there are few reliable data available to the reader and the best plan is to entrust such a problem to the information and judgment of a reliable electric machinery concern. We expect to have more to say on the determination of the power required for installing motors in old shops in a future issue.

CORRESPONDENCE.

MASTER MECHANICS WANTED.

Editor American Engineer and Railroad Journal:

The editorial entitled "Master Mechanics Wanted," in the January issue of your paper, induces me to ask the question: How can a man in a subordinate position on a railroad find out that there are positions unfilled on other roads ?

A man in such a position usually does not have the opportunity to become known to the officials of other roads who may have vacancies to fill, and his immediate superiors may often consider it to their interest not to recommend a good man for a position elsewhere, so as not to lose his services on their own road and have to seek new help themselves.

Jan. 4, 1900. O. A.

HEATING SURFACE AND WEIGHT ON DRIVERS.

Editor American Engineer and Railroad Journal:

I think there is an error in the table at the foot of the first column of page 12 in your January issue. In the third line at the left the words "per square foot" should have been omitted. If I understand your purpose, the table should read as follows:

	Union Ry. Consol. Pittsburg.	I. C. R. R. Consol. Rogers.	I. C. R. R. 12-wheel Brooks.	D. & H. Co. Consol. Schenectady.	L. V. Consol. Baldwin.	L. S. & M. S. 10-wheel Passenger, Brooks.
Weight on drivers in lbs ...	208,000	198,000	193,200	157,500	202,232	133,000
Total heating surface	3,322	3,203	3,500	3,349	4,103	2,917
Weight on drivers divided by heating surface.......	63	61.2	55	47	49	45.5

Without having given this subject much attention, I had always thought that the relation between the boiler power and total weight was the important one, as this would be likely to show the excess in the amount of dead weight of 10-wheel and 12-wheel engines over moguls and consolidations. My sympathies were with the moguls and consolidations, but of late I have concluded that extra dead weight occasioned by the additional wheels for a 4-wheel instead of a pony truck is not the most important consideration in this case. If the extra pair of wheels means more heating surface, and consequently more power to put steam into the cylinder at critical point on the road, it is folly to object to their weight. The meat of this question is how much boiler power is to be had for a certain weight on drivers, and I believe your basis to be correct.

The chief engineer fixes the limits of the weight on drivers, and this fact often determines whether an engine shall be a 12-wheeler or consolidation, a 10-wheeler on an 8-wheeler; because, if the boiler needed is part on the smaller number of wheels, the weight would exceed the limits given.

I have made quite a number of comparisons on the basis of weight on drivers divided by the total heating surface, and the results are surprising. They indicate that there is no idea of uniformity in the practice of the railroads or the locomotive builders in what I believe to be the vital factor in locomotive power, viz., heating surface. The calculations for passenger and freight engines are enclosed.

January 9, 1900. F. D. C.

[The passenger engines only are given in the table which we reproduce. These have been worked up with considerable pains, and, as the engines are nearly all well-known designs, the comparison is valuable.—Editor.]

Heating Surface Comparison of Passenger Locomotives.

Road.	Type of Locomotive.	Road Class and Number.	Weight on Drivers. Divided by Total Heating Surface.
P. R. R.	8-wheel	D—16a	48 6
N. Y C.	"	I—928	45.7
Big Four	"	201	39.3
C. R. I. & P.	"	1101	41.7
Ill. Central	"	961	44.3
C. & N. W.	"	A—908	41.7
C., B. & Q.	"	M—550	46.9
C., B. & Q.	Columbia	N—1590	52.2
A. C. Line	Atlantic	....	36.0
Wabash	"	G—	38.8
L. Valley	"	664	39 4
C., B. & Q.	Mogul	H	63.2
Gt. Northern	1"-wheel	150	48.7
G. T. Ry.	"	999	67.4
Southern	"	....	50.3
Wisconsin Central	"	227	50.5
B. & O.	"	....	52.5
N. P.	"	P	45.0
Ill. Central	"	376	58.8
M. C.	"	433	58.1
L. S. & M. S.	"	1 7	47.2

STAYBOLT PROGRESS.

Editor American Engineer and Railroad Journal:

Your article on staybolt progress in the December issue and the communications published in the January issue, have covered all points except one in the study of the life of staybolts. This point is the actual movement of the side sheets and firebox sheets relative to one another, due to the differences in temperatures of the two sets of sheets and the enormous fluctuations of temperature in the firebox itself. The only published record that I have any knowledge of, referring to this subject, is that found on page 27 of the twenty-seventh annual proceedings of the American Railway Master Mechanics' Association for 1894. The committee report on "Cracking of Back Tube Sheets" quotes from a paper read before the Institution of Naval Architects by Mr. Yarrow. This paper discusses the movement of the tube and crown sheets under heavy firing and the method adopted to relieve the stresses of these sheets due to expansion. The relative movement of the crown stays through the top casing sheet is given as being equal to the thickness of a penny (English) which would about 3/32 inch. This is the only experiment, I believe, which has been made to determine the actual movement of sheets relative to each other. No definite data being given, we can only base our deductions on this test in a general way. They show, however, that the crown sheet for some 8 or 10 inches from the front end was supported entirely by the tube sheet, as the stays were free at the point referred to, having moved outwardly through the casing top sheet. From the information contained in this article we cannot determine definitely whether the next succeeding rows of roof stays back of the second row were in tension or compression. Following this line of reasoning, it would seem that the first few rows of radial stays or crown bars with sling stays were in compression and not in tension for which purpose they were designed. This, then, must be true of any type of boiler with stayed crowns.

In this connection I would quote some recent history. It was recently proposed to the writer by a locomotive builder to alter the details of the first two rows of sling stays on a crown bar boiler, to allow for expansion, by elongating the holes in the

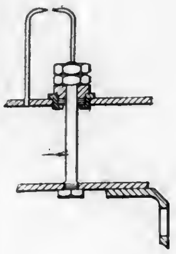


Fig. 1.

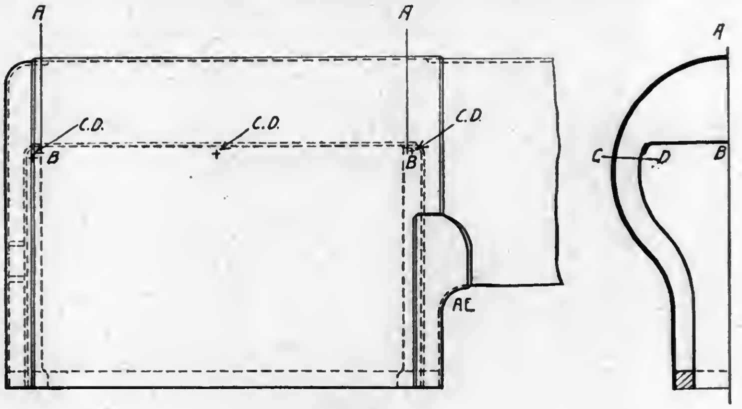


Fig. 3.

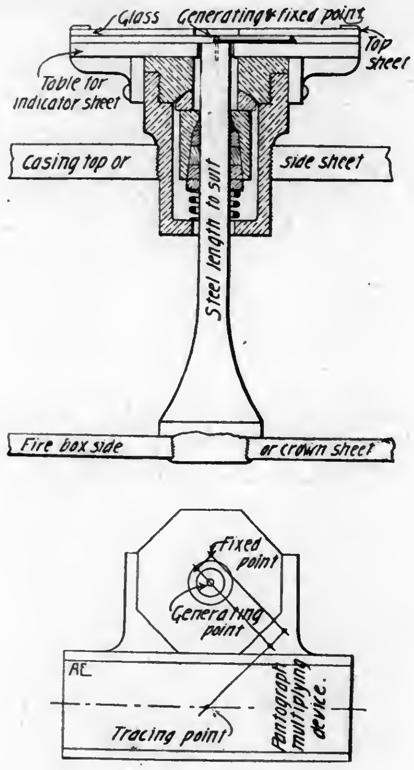


Fig. 2.

lower ends of the stays ⅛ inch. Here we have an unconscious approval of the proposition that the first two rows of crown sheet stays do not stay, and that in view of the fact that the steam pressure carried is 180 lbs. per square inch. The question that now presents itself is: Of what use are the stays on the crown near the tube sheets and door sheets?

Mr. Sanderson's communication of last month covers the question of expansion of firebox sheets pretty thoroughly and presents various points of interest in the nature and location of the line of fracture of staybolts. He refers also to the fact of excessive local heating causing unusual and unlooked for strains in sheets and staybolts, and among ofter things cites the irresistible forces at work due to expansion. Prof. Goss in a recent article before one of the Eastern railroad clubs also quotes some stupendous figures on this same subject.

We have arrived at the point where the concensus of opinion is that in the sheets of the firebox of an internally fired boiler numerous unknown stresses and movements of sheets exist, yet there is no record of these having been studied logically nor are these conditions allowed for in new designs.

The nearest approach we have made to this subject is the vibratory test of staybolts. It is shown that these investigations have developed better practice and lengthened the life of stay bolts. These tests are assumed to give the material an arbitrary deflection of ⅛ inch vertically or in one direction only. The test proved certain facts, and, as shown in the December issue, the number of vibrations any stay bolt material would stand varied with the relative position of the internal structure and the direction of the bend or vibration. The logical result of these tests points to the revolving tests as being the most rational, as is suggested by your article.

We now have two important points forcibly brought to our notice: First, that the firebox sheets "do more" to a very appreciable extent, and, second, that stay bolt material of a certain form of structure gives excellent results, shown by service and vibratory tests. It appears to the writer, second, that the conclusions to be reached from the information at hand is to assume that the movements of expansion due to temperature fluctuations are not in any given direction at any certain point, but that this movement may be in any direction radiating from this point, and that the proper way to test stay bolts would be by the revolving method. The other points at issue, such as riveting and heading stay bolts, loose and tight fits in sheets and the thickness of the sheets themselves, are vital and should be considered carefully in design and building.

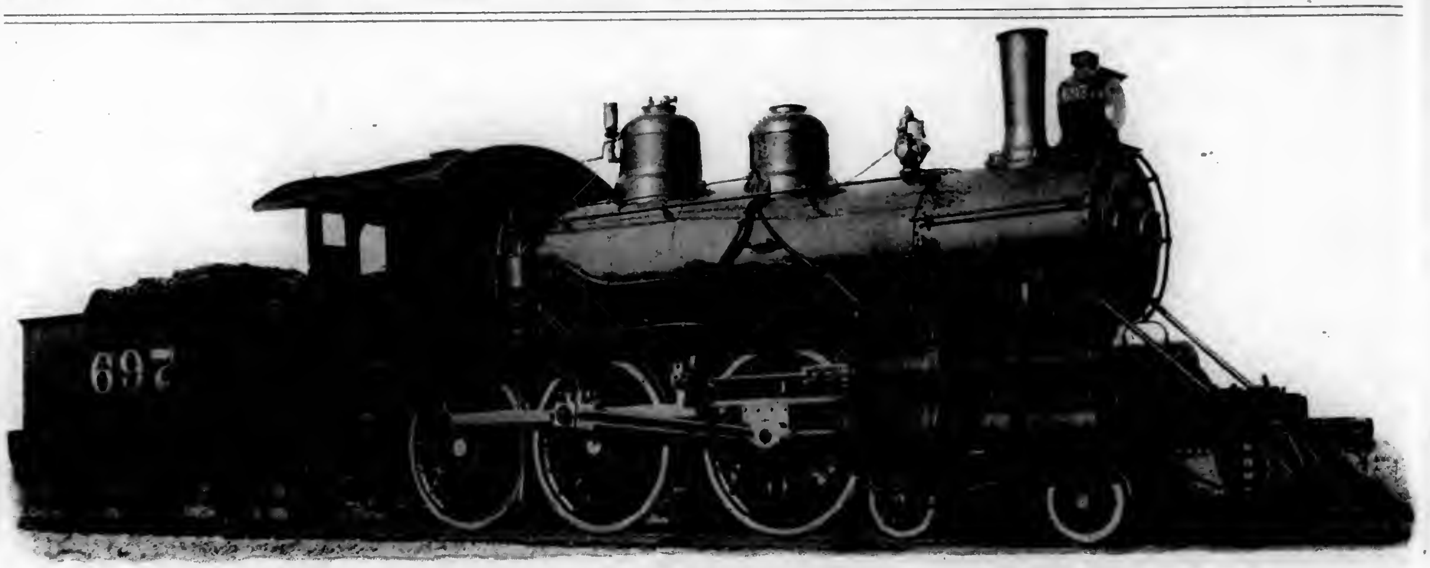
Assuming, then, that there is unequal expansion in the various parts of the firebox sheets and that these expansions and stresses are cumulative, would it not be well to inaugurate a study of these movements as being in line with "stay bolt progress" and progress of boiler design? To advance this subject a step further, I hand you a few sketches of a device designed to record the relative movements of the sheets of the boiler in regard to one another. In this design it is proposed to place in the crown and side sheets of the firebox at the points A B an C D marked in Fig. 3 a fixed steel stud, designed as a beam of uniform strength for the given or required length. The stud is to pass through the casing side or top sheets in a stuffing box provided with metallic packing in such a manner that it will be free to move in any direction due to the movement of the sheet to which the stud is attached. A recording mechanism of pantagraph construction is shown to multiply the motion definitely, say 10 times, in order that the direction and extent of movement can be readily studied. As shown, the device is intended for recording movements in a horizontal or vertical plane, according to the position of the stud on the side or crown sheet. For studying the complex motions of the crown sheet at the junction with the tube or door sheet as at A B, Fig. 3, a second pantagraph could be attached to give the record in a plant parallel with the axis of the stud. A careful design of details and as careful calibration should make a device of this nature an exceedingly valuable piece of apparatus in the study of boiler design.

The sketches presented are given as a suggestion for a line of investigation. If anyone has already investigated on this line and withheld the information, he should at once discover himself so that the work can be prosecuted from the point where he left off.

The writer would hazard the opinion that an investigation on the line suggested will upset a large number of preconceived notions on boiler design and will go a long way toward starting us on the right track to successfully design a boiler that is theoretically and practically correct.

January 17, 1900. WILLIS C. SQUIRE, M. E.,
Atchison, Topeka & Santa Fe Railway.

We learn that Manning, Maxwell & Moore, whose principal offices are at 85 Liberty Street, New York, are compiling a new catalogue devoted exclusively to the illustration of iron-working machine tools. Those who have new tools that they would desire to have illustrated in this catalogue should immediately communicate with Manning, Maxwell & Moore at their New York office, marking their communication "Catalogue Department," which will insure its receiving prompt attention.



Four-Cylinder Tandem Compound Locomotive—A. T. & S. F. Railway

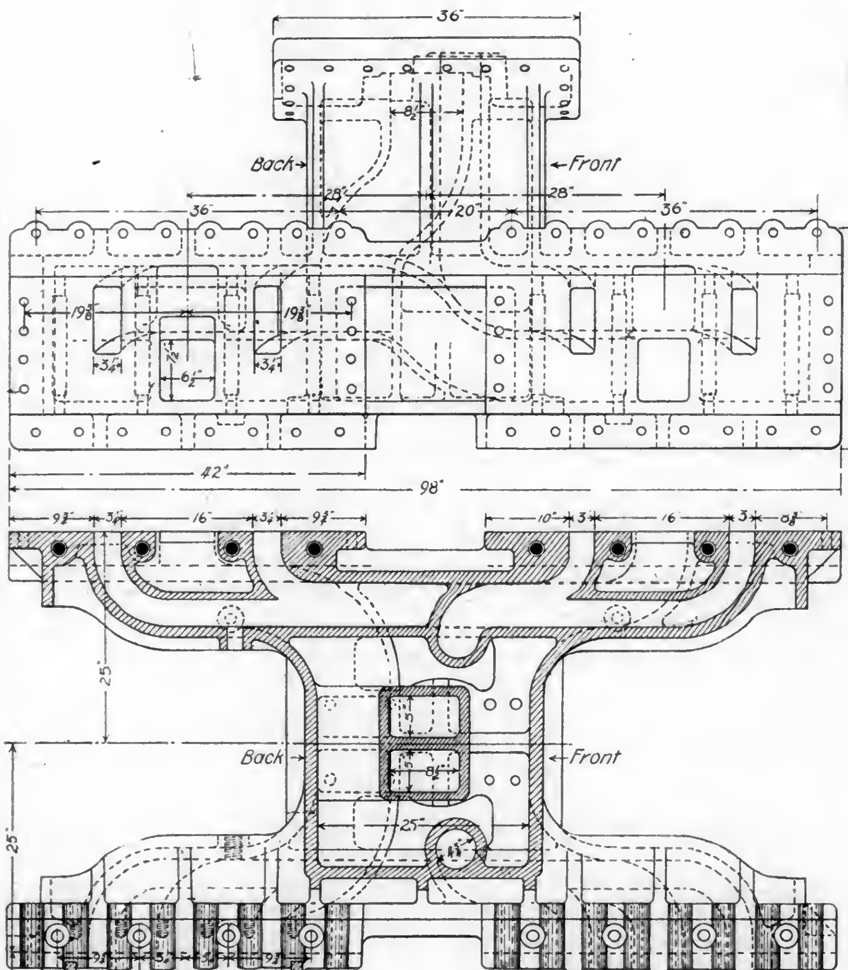


Fig. 2.—Arrangement of Saddle and Cylinders.

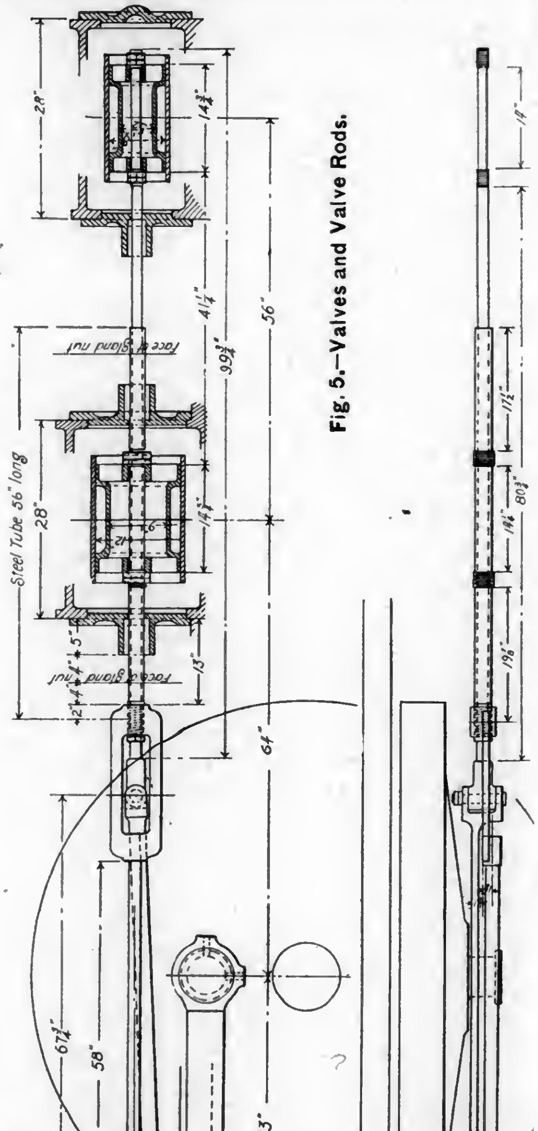


Fig. 5.—Valves and Valve Rods.

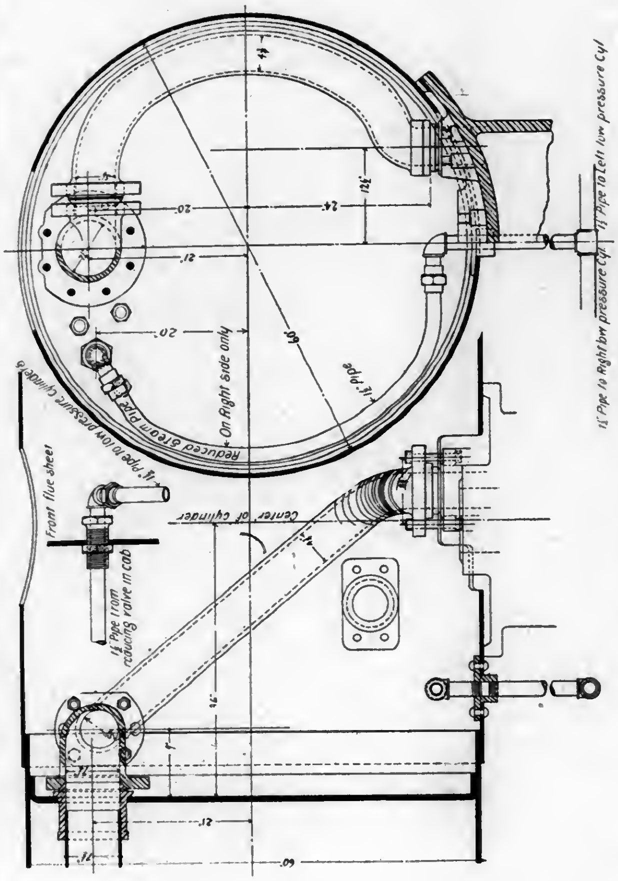


Fig. 4.—Arrangement of Steam Pipes.

FOUR-CYLINDER TANDEM COMPOUND LOCOMOTIVE.

Atchison, Topeka & Santa Fe Railway.

The principles of the tandem type of four-cylinder compound locomotive as worked out and patented by Mr. John Player, Superintendent of Motive Power of the Atchison, Topeka & Santa Fe Railway, were described on page 211 of our issue of June, 1899. At that time the application had been made only to freight locomotives, but it has now been applied to ten-wheel locomotives in passenger service, one of which is shown in the accompanying engraving from a photograph. The chief features of this design are the tandem arrangement of the cylinders, piston valves without packing rings and an arrangement of the attachment of the valve stem for the high-pressure cylinder to its rocker arm in such a way as to permit of adjustment of the cut-off in the high-pressure cylinders to change the ratios of expansion.

The saddle casting has a narrow portion at the center between the frames, and enlarges at the frame to a length of 98 inches on each side, and the cylinders are bolted to the frames and the saddle casting independently with a space of 20 inches between the ends of the cylinders. The arrangement of the steam and exhaust passages is indicated in Fig. 2. Fig. 3 shows half sections through one of the low and one of the high-pressure cylinders, respectively. Fig. 3 shows the arrangement of the steam piping in the front end, including the small pipe for admission of high-pressure steam to the low-pressure cylinders in starting. The valve gear back as far as the rocking shaft is seen in Fig. 5. This illustration shows the method of working the high-pressure valve by a stem which passes through the hollow stem of the low-pressure valve. The high-pressure valve stem connects to a rod attached to its upper rocker arm with an adjustable attachment clearly indicated in the drawing. The valves are in the form of hollow shells without packing of any kind and the admission of steam is from the ends.

The cylinders are 14 and 24 by 28 inches; the driving wheels, 77 inches in diameter; the heating surface, 1,923 square feet; grate area, 26½ square feet, and the boiler pressure, 200 pounds. The weight of the engine is 169,000 pounds, of which 123,000 pounds are on the driving wheels.

This design appears to be very successful on this road. It has demonstrated the possibility of omitting the packing rings from piston valves and has shown the possibility of adjusting the ratio of expansion by varying the travel of the high-pressure valve independently of the low-pressure valve.

We are indebted to the "Railway Master Mechanic" for these engravings.

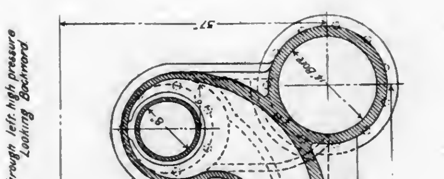


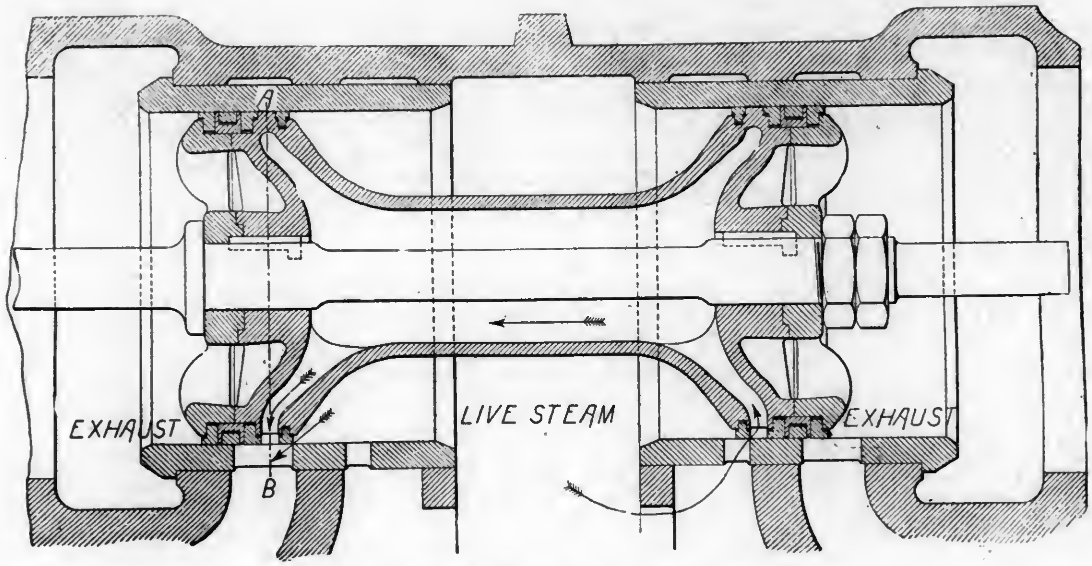
Fig. 3.—Transverse Sections of Cylinders.

The typical dimensions for standard box cars has occupied the attention of the American Railway Association with the result of proposing the following: Length inside, 36 feet; width inside, 8 feet 6 inches; height inside between the top of the floor and the under side of the carlines, 8 feet. A committee of the Central Railroad Club reported at the January meeting approving all of these dimensions providing certain roads would increase their clearances, and suggesting a reduction of height to 7 feet 9 inches if they should remain as at present. This looks rather promising, and it is to be hoped that the Association's recommendation will have the weight it deserves in the final decision.

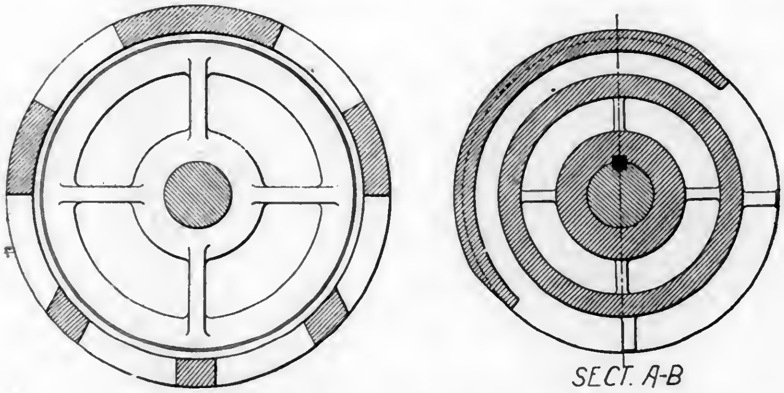
Another record-breaking run of the "fast mail" train of the Burlington road was made a short time ago. The train, pulled by engine 1592, left Burlington, Iowa, 36 minutes late, and arrived in Chicago on time. The distance is 206 miles, and was covered in 209 minutes, including all stops. The run of 83 miles from Mendota to Chicago was made in 76 minutes—the best time ever made between those points. The 46 miles between Mendota and Aurora was covered in 39 minutes. Nearly all the way there was a heavy head wind and the train was unusually heavy.

PISTON VALVES WITH ALLEN PORTS.

Objection has been made against piston valves because of the difficulties in applying to them the principle of the Allen port. The design illustrated was prepared by Mr. Chas. M. Muchnick, of the Compagnie de Fives-Lille, France, to suit the dimensions of locomotives of the Pekin-Hankow line in China, to meet this objection. Mr. Muchnick, believing that it is not at all improbable that the same objection has been made by advocates of the Allen valve in this country, sends us the drawings to illustrate the valve as a suggestion.



Muchnick's Piston Valve with Allen Ports.



Sections of Piston Valve with Allen Ports.

The construction of the valve is clearly indicated in the drawings and requires no detailed description. It differs very little in form from the valves of the Brooks Locomotive Works, with the exception that instead of the hollow open-ended cylinder of the Brooks designs this one is closed, except for the valve ports at each end and the openings for the valve rod which are cored out. There is a marked difference in the packing, however. In the French valve the packing is in the form of spring rings of small cross sectional area to make them flexible in order to reduce the friction against the valve bushings as much as possible, and yet insure steam-tight joints. Apparently no effort is made, except in accurate fitting, to prevent steam from getting inside the rings to set them out against the bushings.

Mr. Muchnick, commenting upon the design, notes that, while this valve embodies all of the virtues of the slide valve of the Allen type, it also overcomes some of the defects of that valve; for example, the breakage of valves due to imperfect placing of the cores, increase of weight and of total size and area of the plain valve. Also, since the exhaust passages, when piston valves are used, are made considerably larger than with slide valves, it may be supposed that the greater back pressure due to insufficient exhaust opening in the latter to exhaust the greater amount of steam admitted into the cylinder on account of the double port opening cannot occur when the Allen principle is applied to the piston valve.

The plan shown takes live steam at the center of the valve like the piston valves in use on the Norfolk & Western Ry.

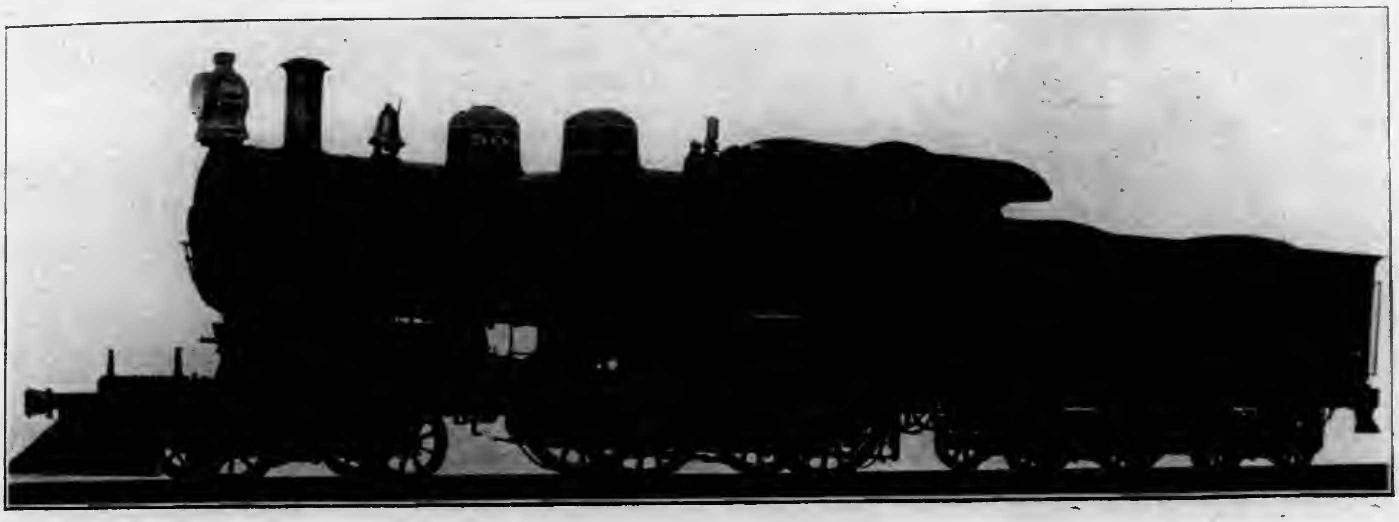
The increase of power of the engine due to the improved balancing of the piston valve is one of the strong points, and if this design should add to this the advantages of the Allen port for improving the admission of steam and also reduce the back pressure and the weight of the valve, it certainly has much to recommend it, especially for fast passenger service.

A gift of $300,000 recently made by Andrew Carnegie, to which $200,000 will be added by the Trustees of Cooper Union, in New York City, will enable that institution to complete the original plan of the founder, Peter Cooper, and open a day school of mechanic arts. The night school has been doing excellent work for years.

IMPROVED ENGINE FRAME CONSTRUCTION.

In an article published in the January issue of this journal on the subject of Improved Engine Frame Construction and Its Relation to the Proper Application of Driver Brakes, we inadvertently gave a wrong impression as to the position of The American Brake Co. in connection with this subject. Our article might lead one to believe that others had anticipated The American Brake Co. in improvements and inventions of this character. We are, therefore, pleased to state that as far back as May, 1892, The American Brake Co. designed and patented improvements in engine frame construction with the special view of facilitating the application of the best form of driver brakes.

It is gratifying to note that following the publication of our article in the January number a great deal of interest seems to be manifested in the importance of this question, and we only trust that those who have not already read and considered the article will give early attention to the subject.



Passenger Locomotive—Chicago & Alton Railroad.
Capacity of Tender 6,000 Gallons Water and 12 Tons Coal.

H. MONKHOUSE, *Superintendent of Machinery*. BROOKS LOCOMOTIVE WORKS, *Builders*.

EIGHT-WHEEL PASSENGER LOCOMOTIVES, CHICAGO & ALTON R. R.

The new day trains on the Chicago & Alton between Chicago and St. Louis, are new throughout and are hauled by eight-wheel simple engines with piston valves, recently built by the Brooks Locomotive Works. These locomotives are handsome, and where it was possible the outline of the cab roof and cab windows were made to appear in keeping with the new cars, for which this train is famous. The engines are painted the standard Pullman color, like the cars.

There are no unusual features in the engine design, the engine is not large or exceptionally powerful, but the provisions for long continuous running in the size and capacity of the tender is noteworthy. The capacity is 6,000 gallons of water and 12 tons of coal, which is believed to be the largest ever used in passenger service. A small turbine driven dynamo is mounted upon the boiler for electric lights placed along the running board and under the boiler as well as for the headlight. The chief dimensions and characteristics of the engines appear in the following table:

Fuel	Soft coal
Total weight in working order	139,000 lbs.
Weight on drivers	90,500 lbs.
Cylinders	19 x 26 in.
Heating surface tubes	2,000 sq. ft.
Heating surface, firebox	177 sq. ft.
Heating surface, total	2,177 sq. ft.
Grate area	31.8 sq. ft.
Driving wheels, diameter	73 in.
Wheel base, total, of engine	24 ft. 10 in.
Wheel base, driving	8 ft. 9 in.
Wheel base, total, engine and tender	53 ft. 2½ in.
Length over all, engine	38 ft. 7⅜ in.
Length over all, total, engine and tender	64 ft. 3⅜ in.
Height, center of boiler above rails	8 ft. 11½ in.
Height of stack above rails	15 ft. 1 in.
Truck wheels, diameter	36 in.
Journals, driving axle, size	9 by 12 in., with enlarged wheel fits
Journals, truck axle	6 by 12 in.
Main crank pin, size	6 by 6 in.
Main coupling pin, size	4½ by 4 in.
Main pin, diameter wheel fit	6⅛ in.
Piston rod, diameter	3½ in., with enlarged ends
Main rod, length center to center	105 in.
Steam ports, length	21½ in.
Steam ports, width	2 in.
Exhaust ports, least area	50 sq. in.
Bridge, width	3¼ in.
Valves, kind of	10-in. improved piston
Valves, greatest travel	6¼ in.
Valves, steam lap (inside)	1⅛ in.
Valves, exhaust lap or clearance (outside)	Line and line
Lead in full gear	None
Boiler, working steam pressure	210 lbs.
Boiler, material in barrel	Steel
Boiler, thickness of material in shell	11/16, ¾, ⅝ and 9/16 in.
Boiler, thickness of tube sheet	¾ in.
Boiler, diameter of barrel, front	66⅛ in.
Boiler, diameter of barrel at throat	75¾ in.
Boiler, diameter at back head	66⅛ in.
Seams, kind of horizontal	Sextuple
Seams, kind of circumferential	Double
Crown sheet, stayed with	Radial stays
Dome, diameter	30 in.
Firebox, length	114 in.
Firebox, width	41 in.
Firebox, depth, front	79 in.
Firebox, depth, back	65 in.
Firebox, material	Steel
Firebox, thickness of sheets	Crown, ⅜ in; tube, ⅝ in.; side and back, ⅜ in.
Firebox, brick arch	Self-supporting
Firebox, mud ring, width	Back, 3½ in.; sides, 4 in.; front, 4 in.
Firebox, water space at top	Back, 4½ in.; sides, 5 in.; front, 4 in.
Grates, kind of	Cast iron rocking
Tubes, number	306
Tubes, material	Charcoal iron
Tubes, outside diameter	2 in.
Tubes, thickness	No. 12 B. W. G.
Tubes, length over tube sheets	12 ft. 7⅜ in.
Smokebox, diameter outside	69 in.
Smokebox, length from flue sheet	60 in.
Exhaust nozzle	Single
Exhaust nozzle	Permanent
Exhaust nozzle, diameter	4⅞, 5 and 5⅛ in.
Exhaust nozzle, distance of tip above center of boiler	1 in
Netting	Wire
Netting, size of mesh	2½ by 2½ in.
Stack	Steel taper
Stack, least diameter	13 in.
Stack, greatest diameter	14⅞ in.
Stack, height above smokebox	39 in.

Tender.

Type	Eight-wheel, steel frame
Weight, loaded	120,000 lbs.
Capacity, water	6,000 gals.
Capacity, coal	12 tons
Tank, type	Slope top
Tank, material	Steel
Tank, thickness of sheets	¼ in.
Type of under frame	13-in. steel channel
Type of truck	B. L. W. 100,000 lbs.
Type springs	Triple elliptic
Diameter of wheels	36 in
Diameter and length of journals	5 by 9 in.
Distance between centers of journals	66 in.
Diameter of wheel fit on axle	6⅜ in.
Diameter of center of axle	5⅜ in.
Length of tender over bumper beams	23 ft. 8½ in.
Length of tank	22 ft. ½ in.
Width of tank	9 ft. 8 in.
Height of tank, not including collar	63 in.
Type of draw gear	M. C. B. Janney

EXHAUST AND DRAFT ARRANGEMENTS IN LOCOMOTIVES.

A Review Covering Ten Years.

Mr. C. H. Quereau, Assistant Superintendent of Motive Power, Denver & Rio Grande Railroad, who was selected as Reporter to the International Railway Congress upon the subject of Exhaust and Draft Appliances in Locomotives, has made an admirable review of the progress of the past 10 years and also presents suggestions and conclusions. The complete report is to be found in the Bulletin of the International Railway Congress for December, 1899. A brief synopsis is attempted here.

The conclusions cover American practice and were derived from that of roads having 15,000 of the 36,000 locomotives in use in this country.

In exhaust pipes the tendency is decidedly toward the sin-

gle nozzles, this having been adopted upon two-thirds of the equipment, and is displacing the double pipe. There is a tendency toward reducing the length of the pipe notwithstanding a large average increase in the diameter of smokeboxes in the 10 years. Twenty out of 33 roads in the record have shortened their exhaust pipes in this time. The general adoption of this change would indicate that it was beneficial. The exhaust tip recommended by the Master Mechanics' Association had been adopted by 60 per cent. of the roads, which is presumptive evidence that it is the most efficient form. The reporter made special efforts to ascertain the opinion in regard to the use of bridges or bars in the exhaust tip and found the practice universally condemned, except as a temporary expedient.

Smoke stacks have been reduced in diameter on one-quarter of the roads, the size of the cylinders remaining the same. The cast-iron smoke stack is the favorite with 80 per cent. of the roads and is growing in favor. The diamond stack is standard on but one railroad system, and it is significant that two roads formerly part of that system have discarded the diamond stack upon separating from that system. From these facts it seems reasonable to infer that the diamond stack is inferior in efficiency to the straight or taper form. Mr. Quereau finds that there are no definite rules for varying the stack dimensions for different sizes of cylinders. He believes that the rule given by the Master Mechanics' Association Committee concerning the relation between the stack and the exhaust tip has had considerable influence. Seventeen roads have used variable exhaust tips, and with unfavorable results. The principle is good but they require too much care to keep them in good working order.

The use of draft pipes with extension front ends has increased considerably during the past few years. They increase the draft effect and increase the efficiency of the exhaust by permitting an increase in the size of the tip, which reduces the back pressure. Draft pipes have been at a disadvantage on account of defective fastenings, which have, in many cases, worked loose and caused delay on the road. This, however, is not the fault of the device, but of its attachment.

The original purpose for which the extenued front end was designed was to serve as a receptacle for the cinders, but it is a failure in this respect. The fact that 16 out of 25 roads reporting have shortened their extension an average of 17 inches in the past 10 years shows quite conclusively that experience has demonstrated that it does not accomplish the end for which it was designed, or that the gain in draft by shortening is more important than the original purpose. The reporter believes it to be probable that with the extended front end a design may be developed which will leave out the baffle plates and depend entirely on draft pipes for the distribution of the draft, and that such a design would be more efficient than those which depend on the baffle plate.

Mr. Quereau made a study of the von Borries-Troske tests at Hanover, in connection with his paper. (These tests were translated in full in our volume LXX of 1896.) Giving due consideration to the eminence of the experimenters, he observes that as they did not use an actual locomotive, but an improvised piece of apparatus to represent the conditions of the front end of a locomotive, without having even a representation of a stack, their results cannot be considered as representing the conditions of practice. The stack has an important influence on the draft effect and so also does the back pressure, which, in the German tests, was assumed to be constant. Furthermore, the German tests considered only the vacuum produced without taking into consideration the fact that it is produced by back pressure. Mr. Quereau shows clearly that the efficiency and not the vacuum is the important factor. The Master Mechanics' Association tests of 1896 were given the preference in the opinion of the reporter because they were carried out on a locomotive with a stack in place and with means for recording the back pressure and of obtaining the measure of efficiency of the exhaust. This ground is apparently well taken, the preference for the Master Mechanics' findings will no doubt be assailed, but the defence appears to be strong. Mr. Quereau recommends that where the conclusions of the Master Mechanics' Committee and those drawn from the Hanover tests do not agree, the Master Mechanics' conclusions should prevail. The chief differences are with reference to the shape of the exhaust tips, the effect of a bridge in the exhaust tip, the shape of the exhaust jet and the height of the tip with reference to the stack. It is clear that in all of these the actual locomotive conditions are absolutely required for intelligent opinion. No one, however, has assailed the German tests before, and the result, we should say, will be to advance the locomotive testing plant as a piece of test apparatus.

CENTER OF GRAVITY OF A 108-TON LOCOMOTIVE.

A method of ascertaining the height above the rail of the center of gravity of a locomotive devised by Mr. G. R. Henderson was illustrated and described in a recent issue of this journal. Through the courtesy of Mr. Reuben Wells, Superintendent of the Rogers Locomotive Company, we have received a description of another method which was applied to the very heavy consolidation locomotive built by that company for the Illinois Central and illustrated elsewhere in this issue.

This operation was carried out on this engine as a whole and in working order by suspending it on the upper surfaces of two 3-inch steel pins or pivots; the one at the front being located 6 inches in front of the cylinder saddle, and the back one 6 inches back of the back end of the boiler, and both the same distance above the rails and on the vertical center line of the engine. The engine when suspended was complete with all its parts in place and boiler filled with cold water to the second gauge, the drivers and truck wheels all clearing the rails about 2 inches. The engine was as near as practicable in the same condition and of the same weight as it would be in working order. The steel suspension pins were supported at both ends and the bearing surface resting on them was horizontal so as to reduce friction at the bearing point to a minimum. On trial, the bearing points as first located proved to be considerably too high. They were lowered and tested again several times until the engine balanced on the pivots. Screws were used at the ends of the bumper for testing, and to keep the "roll" to either side within limits when the pivots had been lowered to the point of the center of gravity. At that point a lift of about 300 pounds under the end of the bumper was sufficient to cause the engine to turn in the opposite direction to the extent that the bumper at that end was about 8 inches higher than the opposite end. On removing the lifting force the engine would not, of itself, return more than half way back to the vertical position but required a lift of about 100 pounds at the low side to bring it vertical enough to overcome the pivot friction, but when vertical and free, it would remain so. It required about 100 pounds, however, to start it to turn in either direction.

The tests show that the point of suspension was probably as near the actual center of gravity of the engine as it was practicable to locate it. After the adjustments were all made and the center of gravity point found measurements showed the bearing point on top of the steel pin at each end of the engine on which it rested to be 50½ inches above the top of the rails when the drivers are resting on the track. That point is 3¾ inches above the top of the main frames and is indicated in Figure 3 of the description of the engine in this issue.

Assuming the bearing points of the drivers on the rails to be 56 inches apart, then the base on which the engine runs is 1.10 times as wide as the distance its center of gravity is in height above them. Without positive knowledge to the contrary, most persons judging from appearances only would conclude that the center of gravity of a locomotive like this must be considerably above the point given, yet, the tests show conclusively that it is not.

If the center of gravity of a locomotive like this is 10 per cent. less in height than the width of the base on which it is carried, it is probable that the center of gravity could be carried still slightly higher without any detrimental results of consequence as regards the movement of the locomotive along the track.

ECONOMICAL OPERATION OF LOCOMOTIVES.

Pooling, or the "first in, first out" system, is generally accepted as a means for saving large sums in locomotive operation. The advantages are summed up in a recent paper by Mr. M. E. Wells before the Western Railway Club, in an argument which may be summarized as follows:

It enables men to rest while the engines are in use, they are not laid off while the engines are in the shop, the work is better divided up among the men, it makes it possible to do the work with 37 engines that formerly required 52 (in the case cited), which means a saving of $150,000 in the machinery investment; the locomotives may be used almost continuously, the improved methods of inspection result in fewer engine failures on the road, and the greatest possible mileage is made between shoppings.

In the pooling system the question of inspection for defects and loose parts is a most important one. It is equally important whatever system is used, but this discussion brings out the possibility of securing better inspection by providing special round house inspectors for the work. The engineers are not relieved from the duty of looking over their engines before and after runs, but the fact that the special inspectors are never overworked, as are the engineers, by extremely long hours and difficult runs is an important safeguard which has been found effective in preventing break-downs on the road.

Pooling is no longer an experiment. Mr. G. W. Rhodes said that his attention was first drawn to it in 1877. Some objections are made to it on account of difficulties in keeping coal and oil records and it has been criticised because men are supposed to be able to get better results when they always use the same engine. These were given due weight in the discussion and the fact that the details rather than the plan itself concerned the speakers most would seem to indicate that the idea of pooling had gained friends since the subject was before this club in 1896.

Mr. Rhodes cited a case to show that the subject has not received the attention it deserves, as follows:

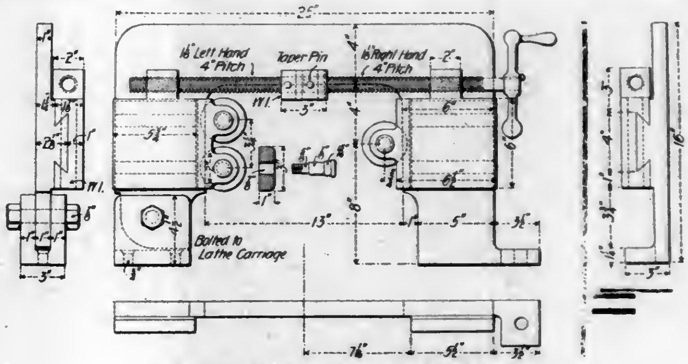
"This spring we had four engines on a certain division, two through passenger trains west and two through passenger trains east. These four engines were worth $10,000 a piece—that is, $40,000. It was found that the run for the round trip was 339 miles, and that the engines could be turned around and brought back to the starting point daily, and by doing so, we would cut the money invested in locomotives in half. Instead of having $40,000 invested in engines we had $20,000. Such economy is wonderful, where it is carried out to great extent. Those two engines now on that run make 339 miles a day, or 10,170 miles a month. What is going to make this method of handling these trains successful? It depends entirely upon the capacity of the engines to make 339 miles a day without a failure."

ROLLER ATTACHMENT FOR AXLE LATHES.

Allegheny Shops, Pennsylvania Company.

The increasing extent of the use of burnishers in the form of rollers for finishing the surface of journals, crank pins and piston rods was commented upon in our May issue of last year, page 156, and through the courtesy of Mr. W. F. Beardsley, Master Mechanic of the Pennsylvania Co., at Allegheny, Pa., we are enabled to illustrate still another burnisher for work of this character.

This device was designed at the Allegheny shops and reference to the drawing shows that it consists of a yoke-shaped frame secured to the carriage of the lathe and supporting three rollers, two at the left and one at the right, which are operated by a right and left hand screw to force the rollers against the axle. The stresses are therefore self contained in the attachment and the thrust due to rolling is not transmitted to the centers, which support the axle. This fixture is hinged on the rear side of the carriage and may be turned out of the way



Roller Attachment for Lathes.

when not in use. It is usually left in position, as its size and form are such that it will clear the tail stock of the lathe.

The rolling is done while the finishing cut is being taken over the wheel fit, whereby time is saved in completing the axle and no time is lost through the application of the burnisher. This arrangement effectually prevents springing the work due to the pressure of the rollers and it entirely relieves the centers from additional stress. It is evident that this feature of the design renders it specially well adapted to work on piston rods and valve stems, in which case the thrust of a single roller would be a serious matter. This attachment is now in use on an axle lathe in the Allegheny shops and is reported to be doing excellent work.

GOOD AMERICAN PRACTICE IN CRANK PINS AND AXLES.

An example of good practice in the design of locomotive details is the comparison, as shown in the "Railroad Gazette," of the axles and crank pins of the main driving wheels of a Lake Shore and Michigan Southern ten-wheeler and a North Eastern (English) ten-wheeler. Mr. L. R. Pomeroy in the June issue of the "American Engineer and Railroad Journal," for 1898, gives two excellent formulas, one for figuring the crank pins and the other for driving axles, from which the following results are derived:

	Lake Shore & Michigan 10-wheeler.	North Eastern 10-wheeler.
Cylinders, in. by in.	20 by 28	20 by 26
Boiler pressure, lbs.	210	200
Maximum fiber stress in main crank pins, lbs. per sq. in.	13,225	20,170
Maximum fiber stress in main driving axle, lbs. per sq. in.	21,700	23,740

In the case of both drivers the crank pins and axles have enlarged wheel fits. The diameter of the Lake Shore axle is 9 inches, with a wheel fit of 9½ inches, while that of the North Eastern is only 7¾ inches, with a wheel fit of 9 inches. The weight on the main drivers of the Lake Shore engine is 44,000 pounds, making a difference of only 1,000 pounds in excess of the North Eastern and has 50 per cent. greater area of journals. The crank pin is also of a larger diameter than that of the North Eastern. Mr. Pomeroy has found from his careful study of the breakages of crank pins and axles a maximum safe fiber stress for iron and steel axles of about 18,000 and 21,000 pounds respectively, and for iron and steel crank pins, 12,000 and 15,000 pounds respectively. From the table it will be seen that the fiber stress in the Lake Shore axles and crank pin are very close to the best practice while those of the English engine are high.

Mr. Thomas Tait, General Manager of the Canadian Pacific, has no misgivings concerning the recent adoption of yellow as a color for distant signal lights on that system. He recently wrote about this important step as follows: "We have adopted the Nels yellow (which I think should be called the Baird yellow) as our standard color for caution, and all of our interlocking plants are now equipped with it and it is giving great satisfaction." Mr. John C. Baird, who was the originator of this glass, informs us that the Canadian Pacific will use green for "all clear" or "proceed" signal, and that a new classification color for locomotive lamps will be adopted.

A Street Transformed into a Shop by an Electric Crane, Baldwin Locomotive Works. Crane Built by Wm. Sellers & Co.

A VALUABLE CRANE.—BALDWIN LOCOMOTIVE WORKS.

The devices and equipment for handling materials generally reflects the real prosperity of manufacturing establishments, and particularly those requiring the movement of heavy pieces. The electric traveling crane has had a revolutionary effect upon shop design and arrangement, and in the development of rapid work for which this country has become famous. A good example of what cranes will do may be seen at the Baldwin Locomotive Works in Philadelphia. Cranes, adapted for the special requirements of each department are contributing in a very important way to the enormous productive capacity of this plant, the works as now equipped being an excellent place to study the problem of moving heavy weights and using space advantageously.

The cranes are the product of Wm. Sellers & Co., and by means of the photograph a unique example is shown of how a crane will render an awkward and unused space available for shop purposes. This crane has a span of 37 feet, a lift of 26 feet and a lifting capacity of 25 tons. It is operated by three motors and is run out of doors, the cage being enclosed and the crane roofed over with corrugated iron. This crane spans the walls of the shop buildings on both sides of Buttonwood Street from Broad to Fifteenth Streets, a distance of about 350 feet. The crane is a very efficient one and capable of handling all of the work required. It renders this entire area available for wheel work and storage for wheels, boilers and other parts for which there is not room in the shops. It saves the erection of another building and the condition shown in the photograph would be entirely impossible without it. The picture incidentally gives an idea of the present crowded condition of the Baldwin works.

THE SLOT IN THE M. C. B. KNUCKLE.

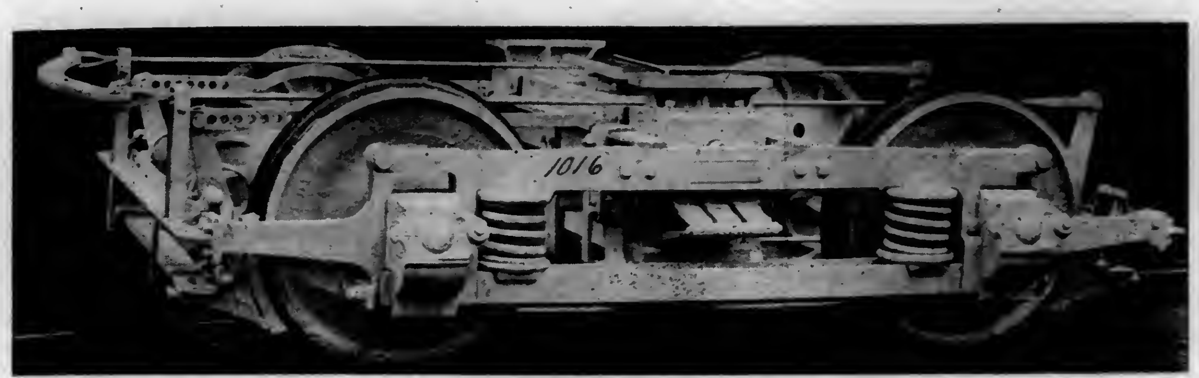
A Serious Weakness.

The fact has long been known that the M. C. B. knuckle is weakened by the slot and pin hole provided for the purpose of coupling with links when necessary, but there are few who will not be surprised by the figures given by Mr. J. W. Luttrell, Master Mechanic of the Illinois Central, before the Western Railroad Club last month.

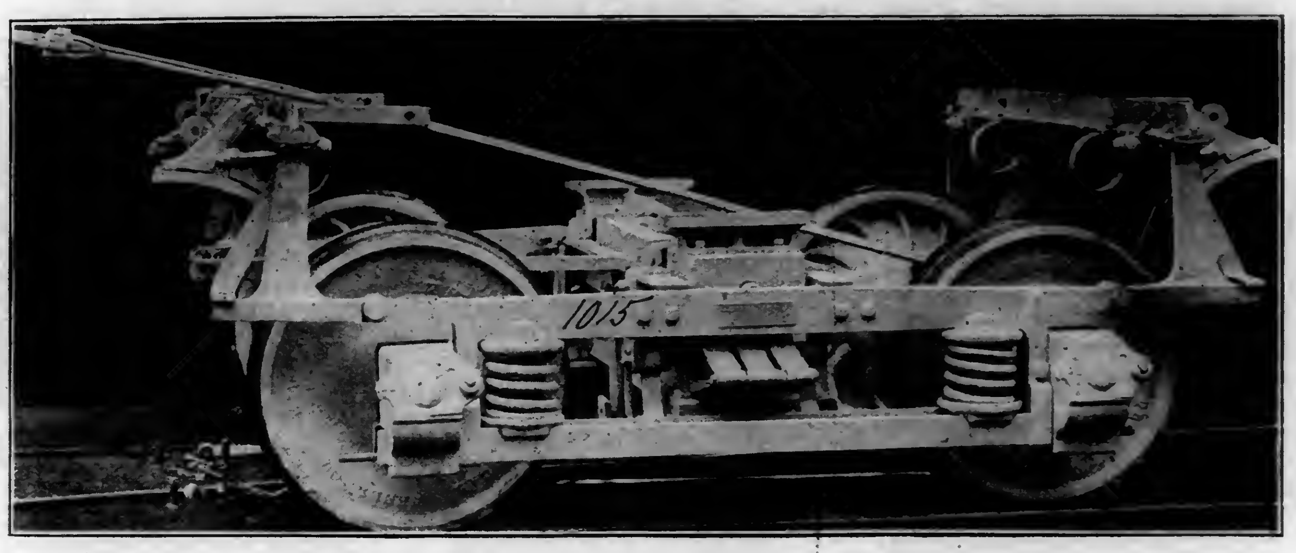
Out of 200 broken knuckles taken at random from the scrap pile, 60 per cent. had broken through the pin hole and 11 per cent. through the link slot, making 71 per cent. due to these two weaknesses.

Statistics showed that in the operation of 31,997 cars with M. C. B. couplers during 12 months, 4,096, or 6.4 per cent., failed from the cause in question. This proportion of the 2,600,000 knuckles in use in the United States means the failure of 166,400 knuckles annually, and at the average price of $1.65 the loss amounts to $274,560 per year.

The advisability of closing the slot and the pin hole as soon as possible is fully realized, and it may be possible to do this at the expiration of the time set for compliance with the safety appliance law. Wearing surface as well as strength is involved. Mr. Luttrell showed that the present wearing surface



New Brill Truck.



New Brill Truck Showing Swinging Jaws.

was about 17½ square inches, and this would be increased 28 per cent., or to 22½ square inches, by closing the slot. This will increase the weight about 9½ pounds and the cost about 38 cents each, but the net saving to the roads in the United States would be $248,872 per year.

The only objection raised to the closing of the slot after the safety appliance act has been complied with, is the frequent necessity for pulling cars out of curved sidings and other curved pieces of track upon which the M. C. B. coupler will not couple. The McConway & Torley Company have put knuckles into service with the slot closed, and in order to permit of pulling cars out of such places a lug is cast upon the top of the knuckle. This serves for the attachment of a switch rope or chain, and an equally simple device is a strong ring placed permanently upon each corner of each car for the attachment of a chain or rope.

The size of the slot has never been established as a standard and it varies, with different knuckles, from 1⅞ to 2¼ inches. It is obvious that a material increase in strength might be had by reducing this width to 1½ inches. This was done experimentally by the Burlington about a year ago, with very satisfactory results. The largest link is 1¼ inches thick and there appears to be no good reason for making the slot more than 1½ inches wide.

A NEW TRUCK BY THE J. G. BRILL CO.

This truck is an improvement upon the type brought out by the J. G. Brill Co. several years ago, and illustrated on page 89 of our issue of March, 1898. It was designed with special reference to the equipment of electric motor cars for the attachment of motors, but is also well adapted to use under passenger cars of any kind. It embodies a large amount of experience and is the result of consistent efforts toward improvement, a motive worthy of most hearty encouragement.

The general practice in passenger truck construction is unaccountably crude. None are so severe as railroad men in their condemnation of complication in new devices, yet they have permitted the provisions for increased stresses in passenger trucks to take the form of adding to the number of parts until a "standard truck"—particularly when it has three axles—is an astonishing mixture of wood and iron with apparently no thought of the immense number of individual pieces, a practice of which no parallel in railroad practice can at this time be recalled.

A glance at this new truck brings the impression of simplicity. It is evident that easy riding and a low center of gravity have also been considered. The features of this design are the cast steel frames, the projection of the equalizers through the bottom portions of the boxes and the location of the equalizer springs close to the boxes. The truck is made very low by this arrangement of the equalizers and this location of the coil springs gives an unusually long spring base and consequent stability. The springs are brought close up to the faces of the inner pedestal jaws and the spring centers are about 10 inches from the centers of the axles, whereas in usual construction this dimension is from 20 to 22 inches. This construction also aims to prevent the tilt of the truck frames upon the application of the brakes, the equalizers being passed through the boxes and held by saddles around the pedestals. For convenience in removing the wheels the outer pedestal jaws are hinged so that it is not necessary to raise the truck.

A number of these trucks are in service, most of them being in Kansas City, Mo.

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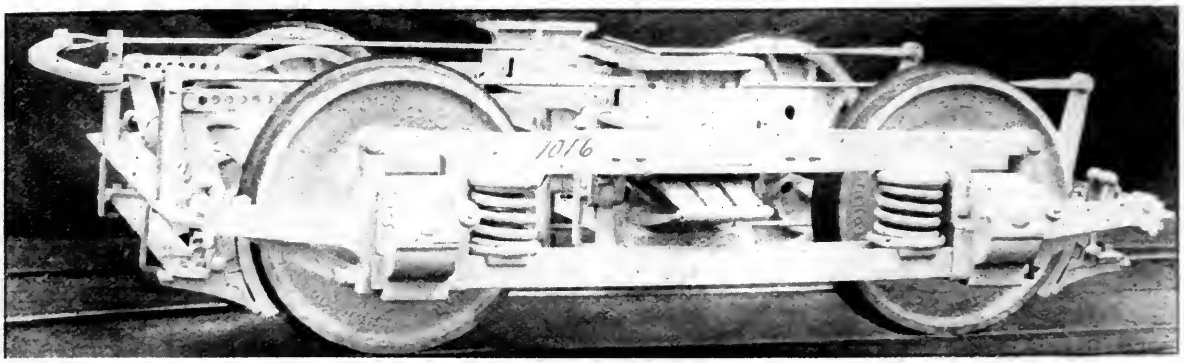

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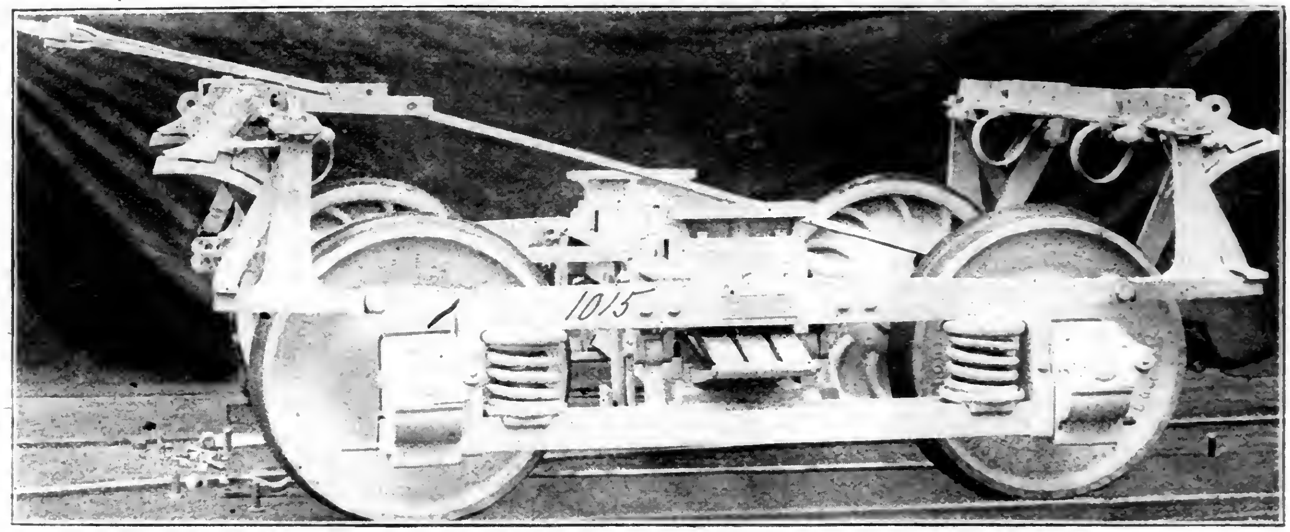

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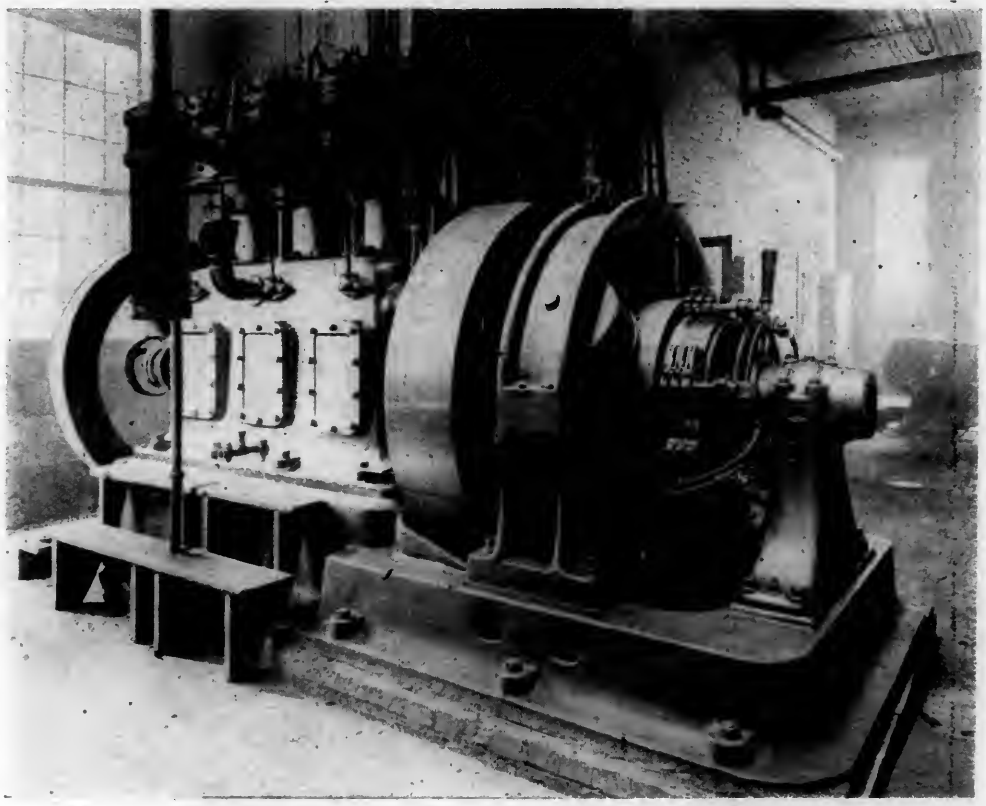

125-H. P. Westinghouse Gas Engine, Direct Connected.
In the Power House of the H. K. Porter Co., Pittsburgh.

A SUCCESSFUL GAS-ENGINE POWER PLANT.

By Burcham Harding.

One of the most successful power plants is found at the locomotive works of the H. K. Porter Company, Pittsburg, Pa. Sharing in the prosperity which has been general with the manufacturers of Pennsylvania, the H. K. Porter Company found it necessary to make considerable additions to their works, and the problem presented itself how best to provide lighting and power. It was decided to abolish separate steam engines and to provide an electrical drive. At first this was done tentatively, by the installation of a 90-horse power Westinghouse three-cylinder gas engine, direct connected to a 60-kilowatt direct-current generator. The successful operation of this unit for more than a year led to the further installation of a 125-horse-power Westinghouse gas engine, direct connected to a larger generator.

These two units are installed in a small extension of the engine room, occupying very little space. Electric current is supplied for 32 arc and 400 incandescent lamps, mainly in the old works, to which additions will be made for the newer extensions. In the machine shop are two 25-ton overhead travelling cranes, operated electrically, and one crane of 15 tons in the foundry. Motors for driving blowers and overhead shafting are now in course of erection, and it is intended that the whole of the works shall be operated electrically. The fuel used for the engines is natural gas, costing 20 cents per 1,000 cubic feet. The gas bill amounts to so small an item as to be virtually a negligible sum. The engineer in charge reports that these gas engines have given the very highest satisfaction, not only from the point of economy in fuel consumption, but also from that of steadiness and regularity. Water for cooling the cylinder jackets is obtained from the city mains, the consumption being about four gallons per brake horse power per hour. The circulation is accomplished automatically by the heat absorbed in the jackets, no pump or other mechanism being required.

The starting of one of these engines is a simple and easy matter, which is accomplished by the use of compressed air. The engine is given a couple of turns by the air cylinder, and when a charge of gas and air has been drawn in, compressed and exploded, the task is accomplished. The air supply is furnished by a small Westinghouse compressor, the air being stored in iron tanks, tested under a pressure of 250 pounds per square inch. The tanks are supplied with a pressure gauge and a safety valve to guard against overcharging, and they are shipped charged to 160 pounds pressure for starting the engine the first time. When the plant is once in operation the compressor is run for a few minutes each day by a belt from a convenient pulley, either on the engine itself or on the line shaft, maintaining the supply in readiness for starting at any time. The entire operation is strictly automatic, requiring no particular mechanical dexterity on the part of the attendant, and consuming less time than it takes to describe it.

INSTRUCTION IN CARE OF JOURNAL BOXES.

New York Central & Hudson River R. R.

In the multitude of details requiring attention on large railroad systems, few are of greater importance than the proper care of journal boxes of cars and locomotives. Indifference as to the importance of this, or a slight lack of knowledge of the actual necessities of properly maintaining the packing, frequently result in numerous cases of hot journals. A good idea in connection with the prevention of hot journal boxes has been developed on the New York Central, from a suggestion made by Mr. H. C. McCarty of the Galena Oil Company.

A full sized model of an M. C. B. journal box, made of galvanized iron and provided with a sheet metal representation of a journal is furnished to the car inspectors at all points where cars are inspected and journal boxes are cared for. This model has lights of glass let into the side in such a way as to give a clear view of the interior of the box, which may be packed and oiled after the manner of the car journal boxes. The idea is to use this in instructing new men in their duties, and also in securing uniformity in the work of the men in all parts of the system. Instruction will be given in the proper method of placing the packing, in oiling it and in the use of the packing hook to keep it loosened up in good condition for properly lubricating the journal. Many inspectors do not give proper attention to the loosening of the packing with the hook, and this is probably as important as the frequent addition of oil to the box. It is customary to pack the boxes up to about the center of the journal, and by aid of the glass windows the exact condition of the waste may be seen at a glance and it may also be ascertained whether the methods in use insure the proper packing of the boxes at the back ends. One of the chief causes of trouble is failure to keep the packing in contact with the journals which results from the

endwise motion. In this way the journal may become dry and an opening at the wheel end may be made which will admit dust from the outside, and at the same time the condition at the other end may be good.

In using the model among men now in service the glass will be covered by slides while the box is packed, and the work may then be inspected by uncovering the windows and the proper instructions given. Its purpose is to insure uniformly good work among the old hands as well as the new. It is the intention of the Galena Oil Company to extend the idea among other roads. Mr. Waitt, Superintendent of Motive Power of the New York Central, has given a great deal of attention to the prevention of hot boxes, and this is in line with other simple and effective remedies, the most important of which is the influence of a carefully kept record of delays which are chargable to the care of journal boxes.

Mr. Waitt appreciates the importance of instructing the men having charge of lubrication so that they will do their work uniformly. He recently issued an elaborate circular of instructions for guidance all over the system and the idea should be taken up generally. The following is quoted from the portion relating to the method of packing and the preparation of the waste:

In packing boxes, the first portion of waste applied is to be wrung moderately dry, and it to be packed moderately tight at the rear end of the box, so as to make a guard for the purpose of not only retaining the oil, but excluding the dust as well. Care is to be taken to keep the waste at the side of the box down below the bottom of the journal bearing about an inch, and also to have that portion of the waste in the front end of the box separate and distinct from that which extends from the front end of the journal to the back of the box. This will avoid derangement of the packing in the rear of the box. The roll of packing which is placed in the front of the box is not to extend above the opening in the front.

At terminals or yards where journal boxes require special attention to the packing, the following practice is to be adopted:

A packing knife or spoon of standard style should be used. This packing knife or spoon is to be used to ascertain whether the packing is in the proper place at the back of the box, and to loosen up the waste at the rear and side of the journal. This particular treatment is given to prevent glazing of the packing (which occurs when it is too long in contact with the journal), and, at the same time, to put the packing in the proper place at the rear of the box. It is desirable to give this treatment at intervals of 500 miles run for cars and tenders if possible.

A small quantity of packing is to be removed from the sides of the journal when found not in a good condition, and this replaced by similar quantity of well-soaked packing. No box is ever to have oil applied before the packing is properly loosened up on the sides and back of the box with the packing iron.

Before applying a bearing to a journal the surface of the bearing is to be examined to insure that it is free from imperfections of any kind that will cause heating. The surface of the bearing is then to be oiled or greased before it is placed on the journal. When applying wheels or axles the journals are to be examined to insure their being free from any imperfections which would cause heating. When wheels or axles are carried in stock, the journals should be protected with a good material suited to protect the surface, without hardening, and one which is not difficult to remove.

When the journal is found heated and there is a good supply of packing in the box, it is evidence of some imperfection of the journal, journal bearing, box, or wedge, and the bearing is to be removed provided the box is heated to such an extent as to require repacking of the box. Boxes which have warmed up slightly will in most cases, by partially replacing with freshly soaked packing, give better results than by entire removal of the packing from the box. When it is necessary and permissible to oil boxes, it should be as short a time before leaving time of the train as possible.

When preparing packing, the dry waste is to be pulled apart in small bunches and any hard particles in it removed. Each bunch is to be loosely formed to facilitate soaking and packing, as in this form boxes can be packed in a more satisfactory manner and with less waste of oil. This loose, dry packing is to be put in soaking cans or tanks provided for that purpose, pressed down moderately tight, then covered with oil and allowed to remain at least forty-eight hours. After being saturated for this length of time the surplus oil is to be drained off, leaving it then in proper condition for use in packing boxes. Standard equipment for saturating and draining packing is to be provided at all points where packing is to be kept for use, unless suitable equivalent equipment is already in use.

DIRECT MOTOR-DRIVEN PROFILER.

The accompanying engraving illustrates a profiling machine driven directly by means of a Bullock motor. This machine is rather a difficult one in which to directly apply an electric motor, as the length of shaft between the motor and spindle is of necessity a varying length, caused by the continuous movement of the carrier. To avoid the use of intermediate belting,

Direct Motor Driven Profiler.

which is generally necessary on machines having a vertical movement of the spindle, the Bullock Electric Manufacturing Company have placed the motor upon a base which is pivoted to the frame of the machine. This allows a vertical movement of the spindle and at the same time the shaft is kept at right angles with it by means of a joint in the spindle. A splined shaft and sleeve connects between motor and spindle, which adjusts itself to the variations in length by the sliding of the shaft within the sleeve.

The motor is fully described in Bulletin No. 2,435, which may be obtained by addressing the Bullock Electric Manufacturing Company, Cincinnati, Ohio.

THE INCREASING WEIGHTS OF LOCOMOTIVES.

The Brooks Locomotive Works have made an interesting comparison of the characteristics of locomotives which they built last year, and in earlier years. This shows the strong tendency toward the use of heavier and more powerful locomotives, and particularly in the comparison of the output of completed locomotives for the years 1891 and 1899, these two years representing the greatest output of these works.

The equivalent weight of locomotives and tenders completed in 1899, if based upon the average weight of those produced in 1891 would be 439 complete locomotives, as against 300 which were actually completed in 1899. The lightest locomotive built during the year was a mogul which with its tender weighed 97,014 pounds, while the heaviest was a 12-wheeler and tender, weighing complete 364,900 pounds. The latter is the huge freight engine for the Illinois Central, with 23 by 30-inch cylinders. (American Engineer, October, 1899, page 315). The comparison referred to has been put into tabular form, as follows:

Brooks Locomotive Works. Completed Locomotives.

	1891.	1899.	Increase.	Average Increase.
Number built	226	300	74	
Weight engines and tenders in working order, lbs.	41,726,350	81,123,600	94½%	
Same expressed in net tons	20,863	40,562	19,699	
Average weight in lbs.	184,629	270,412		85,783 lbs.
Weight, engines only, in working order, lbs.	25,455,100	49,730,400	95 1/3%	
Same in tons	12,728	24,865	12,137	
Average weight, engines only	112,633	165,768		53,135 lbs.
Total weight engines and tenders empty, showing amount of material used in lbs.	24,778,410	57,681,300	93¾%	
Same in tons	14,889	28,841	13,952	

The low cost of rail transportation, made possible by the large locomotive, as compared with the cost of movement by canal, which has always been popularly considered as the lowest standard, was clearly put by President Hill, of the Great Northern Ry. In an interview printed in the New York "Journal of Commerce," he said: "Elliminating the terminal charges at New York, the rates by rail from Buffalo are already lower than any canal, small or large, could carry grain for, even if the Erie Canal was deepened to 50 feet."

PERSONALS.

Mr. F. B. Shepley has been appointed Purchasing Agent of the Fitchburg, with office at Boston, in place of Mr. G. J. Fisher, resigned.

Mr. B. Haskell has been appointed Superintendent of Motive Power of the Pere Marquette Railroad Company, with headquarters at Saginaw, Michigan.

Mr. Brown Caldwell has resigned as Secretary of the Peerless Rubber Company, to accept the position of General Eastern Representative of the Sargent Company, with offices at Pittsburg and New York.

It is officially announced that Mr. S. M. Felton, President of the Chicago & Alton, will also assume the duties of Mr. C. H. Chappell, Vice-President and General Manager, who retired from this position on Jan. 1.

Mr. F. H. Greene, Chief Clerk of the Motive Power Department of the Lake Shore & Michigan Southern, has been appointed Purchasing Agent of that road, with headquarters at Cleveland, O., vice Mr. C. B. Couch, resigned.

Mr. F. W. Deibert has resigned as Master Mechanic of the Chicago ,Milwaukee & St. Paul, at West Milwaukee and will go with the Baltimore & Ohio as Assistant Superintendent of Motive Power, with headquarters at Newark, Ohio.

Mr. J. O. Pattee has resigned as Superintendent of Motive Power of the Great Northern. His position has been abolished and the position of General Master Mechanic has been created, to which Mr. G. H. Emerson, Master Mechanic at Larimore, N. D., has been appointed.

Mr. W. G. Collins has resigned as General Manager of the Chicago, Milwaukee & St. Paul, to take effect February 1. Mr. Collins entered railway service in 1868 with the Chicago, Milwaukee & St. Paul, but was later on the Northern Pacific and the Canada Southern. He returned to the Milwaukee road in 1873, since which time he has held various responsible positions.

Mr. T. W. Demarest, Master Mechanic of the Pennsylvania shops at Logansport, Ind., has been appointed Superintendent of Motive Power of the Pennsylvania Lines West of Pittsburg, Southwest System, to fill the position made vacant by the resignation of Mr. S. P. Bush, who recently succeeded Mr. J. N. Barr on the Chicago, Milwaukee & St. Paul. Mr. Demarest began his railroad work in the Pennsylvania shops at Indianapolis, and after being appointed General Foreman, he was recently transferred to Logansport as Master Mechanic.

Thomas B. Twombly, formerly General Master Mechanic of the Chicago, Rock Island & Pacific, died at his home in Chicago, October 31, aged seventy-six years. After serving his time as an apprentice in the machine shops of the Cocheco Cotton Mills, at Dover, N. H., he entered the service of the Connecticut River Railroad, as locomotive engineer. In 1859 he was Master Mechanic of the Newburyport & Georgetown, and foreman of the machine shops of the Mississippi & Missouri, in 1867, which position he left to enter the service of the Rock Island System as General Master Mechanic, and remained in this capacity for nearly 24 years. Among several interesting papers concerning Mr. Twombly received from Mr. Geo. F. Wilson, Superintendent of Motive Power of the Rock Island, is a letter of recommendation given Mr. Twombly by President Poole of the Newburyport Railroad in 1857. Mr. Poole stated that he was "a capable, faithful and industrious man." To these qualities he owed his success and advancement.

The death of Charles P. Krauth, Secretary and Treasurer of the McConway & Torley Company, December 27, in Pittsburg, is an unusual loss, for such men are needed and are very rare. He was a man of ability, possessing to an unusual degree the qualifications which make business success, and with his delightful personal attributes he gained a high place in the esteem of those with whom he came in contact, both in business matters and otherwise. He contributed an important part of the success of the firm with which he was connected. Mr. Krauth was born in Winchester, Va., in 1849. After graduating from the University of Pennsylvania he studied mining engineering for eight years at Freiberg, Germany, and on his return to this country entered the service of the Pullman Palace Car Company as District Superintendent. He afterward held a similar position with the Wagner Company, and in 1888 became Secretary of the McConway & Torley Company, and was one of the leaders in building up the extensive interests of this concern.

BOOKS AND PAMPHLETS.

Railroad Curves and Earthwork. By C. Frank Allen, S.B., M. Am. Soc. C. E., Professor of Railroad Engineering in the Massachusetts Institute of Technology. Spon & Chamberlain, New York. Leather, 4 by 6½, pp. 194. Price $2.

This is an admirable book on railroad curves and earthwork. In the variety and number of field problems and in the mathematical statement and solution of these problems, the work is very satisfactory. The frequent use of the convenient versed sine is to be commended. The treatment of compound curves, vertical curves, turnouts, and crossings is good and is an im-

provement over that given in most field books. The chapter on spiral easement curves describes the cubic parabola, a curve which is not very satisfactory for easements of sufficient length to be of value for high speeds. It contains no application to curves in existing track. The chapters devoted to setting stakes for earthwork, to the computation of earthwork and haul, to earthwork tables and diagrams, and to haul and mass diagrams are especially clear and discriminating and altogether form perhaps the best presentation of this subject yet published. The usefulness of this part of the work is lessened by the limited number of tables and diagrams. It is to be hoped that the author will include in the next edition a wider variety of bases and slopes and thus make it a standard treatise on earthwork. The author has seen fit to retain the old definition of degree of curve based always on a full chord of 100 feet. This is to be regretted, since engineers generally use shorter chords for the sharper curves, and the recognition of this use greatly simplifies calculations and tables. Some of the newer field books have based their formulas and tables upon the modern definition. This is not a railroad engineers' field book in the usual sense, since it does not contain trigonometric and other mathematical tables, but as a treatise for students and as a reference book for curve problems and earthwork it is a valuable work and is worthy of a place in the library of the engineer.

Engineering Rules and Instructions of the Northern Pacific Railway. By E. H. McHenry, Chief Engineer. Published by Engineering News Publishing Co, New York, 1899. Price 50 cents.

This little book of 75 pages contains a concise and up-to-date treatment of the subject of the engineering department of a railroad and rules for its government in organization and work. Under "Location" a great deal of valuable matter in regard to traffic, curvature, grades and maintenance is given. The power of locomotives and the effect of grades upon their economy of operation are discussed. Other chapters treat of surveys and construction, track and ballast, bridges and culverts, accounting and supplies. The great importance of the location and original construction of the road upon the cost of operation is better presented in this book than in any work since the appearance of Wellington's work on location. Mr. McHenry has put his ideas into department rules and many will be indebted to him and "Engineering News" for making them available in so convenient a form.

Kinematics of Machinery. By John H. Barr, M.S., M.M.E., Professor of Machine Design, Cornell University. New York: John Wiley & Sons; pp. 247, 8vo, 200 illustrations. Price $2.50.

In this book is presented in condensed form the leading principles and methods which are of most importance in a general course in kinematics. While it is not in any sense a complete treatise on the subject, yet it will be found to contain the essential principles of the science. In its general arrangement Professor Barr has closely followed Stahl & Woods' "Elementary Mechanism," but this has been greatly strengthened by the introduction of much additional matter and applications of such important conceptions as instantaneous centres, velocity diagrams, centroids, axiods, and linkages. The treatment of these subjects follows closely that given by Professor Kennedy in his admirable work on the "Mechanics of Machinery," which adds very much to the value of the book. The treatment of many topics has been necessarily somewhat abridged, but this is an advantage rather than otherwise. This is notably true of that portion relating to toothed gearing which frequently receives attention out of all proportion to its value. The subject of cams is presented in a practical manner, possibly somewhat too briefly, but the reader will have no difficulty in obtaining a good knowledge of this branch of kinematics, if he works out the interesting problems which accompany the text and are designed to illustrate the principles treated. Professor Barr has shown good judgment in selecting his material for this book which can be recommended as a well-arranged, clear and concise treatise on the subject.

The press-work and illustrations are of a high order of merit and add much to the value of the book.

The Use of the Slide Rule. By F. A. Halsey, Associate Editor "American Machinist." Van Nostrand's Science Series. Published by D. Van Nostrand Co., 23 Murray St., New York: 1899. Illustrated. Price, 50 cents.

This is an excellent instruction book on the use of the slide rule. It is elementary and the author's purpose seems to be to enable one who is entirely ignorant of the theory of the instrument to use it intelligently. The explanations are accompanied by engravings showing the various settings, as they are actually made for solving various problems. The book ought to have a wide circulation, and its effect will undoubtedly be to greatly increase the use of the slide rule as a labor saver to the engineer. The work is systematically arranged, and the student is led very gradually into the more difficult problems. His difficulties have been foreseen and provided for, but the work is not obscured by too much of the theory of the subject. The author's style is very clear, concise and satisfactory. The book closes with chapters on special forms of computers involving the principles of the slide rule.

Notes on the Construction of Cranes and Lifting Machinery. By E. C. R. Marks, Asso. Member Inst. C. E., Member I. M. E., etc. New and enlarged edition. D. Van Nostrand Co., 28 Murray St., New York: 1899. Price, $1.50.

This little book describes English practice in hand and power cranes, with their accessories for a variety of purposes. The chapters are: Pulley blocks, crabs and winches, double-purchase crabs, treble-purchase crabs; hand, pillar, whip, foundry, wharf and overhead traveling cranes; steam power hoists, cage and car lifts, locomotive cranes, rope driven cranes, jacks, etc. The closing chapters describe ship derricks and electric cranes, showing methods of attaching motors. It is not the best that may be done with this subject, but it covers quite a large portion of the field of hoisting appliances. Those who are infrequently called upon to design hoisting apparatus will find it useful, and more so than will expert crane designers. It is hardly up-to-date as a treatise because it does not touch upon the important development of elevating and transporting machinery in the United States, which is unique and even revolutionary. The book is good, but it would be much more valuable if it gave a complete treatment of the subject. The engravings are not good.

Problems in Machine Design. By Charles H. Innes, M.A., Engineering Lecturer at the Rutherford College, Newcastle-on-Tyne, England. Second edition. D. Van Nostrand Co., 23 Murray St., New York: 1899. Price, $2.00.

This book was written to supply engineering students with a book on machine design which should carry them a step further than the mere formulae for application to their problems. The author works out examples to explain the use of the formulae; he does not write for those who are content to copy the designs of others. The work is purposely incomplete because the author intends to write again on the subject of the design of complete machines; in this case he treats the elements only. There are many books on machine design. The reviewer believes that the best works on machine design are those which offer the theoretical treatment with derivation of formulae and also present the results of practice. There are many stresses in machinery that are misunderstood, and the best formulae are those which are made to fit the practice which is found to be successful. This work presents chapters on graphic and other methods of finding longitudinal stresses in framed structures, bending moments, tensile, shearing and compressive stresses, and then takes up the practice recommended by such bodies as the Board of Trade. The piston rod is treated as a column, and formulae obtained; then the practical side is brought in by a table representing marine stationary and locomotive practice. Shafting is treated in a similar manner, the evident tendency being toward marine practice. A chapter on expansion valve gears treats of several types and includes a few fly-wheel governors. A chapter gives the most recent methods of balancing multiple expansion marine engines, and the book closes with a study of the distribution of work in the compound engine. A large amount of attention is given to cranks, shafts, both hollow and solid, and riveted joints. We find a number of valuable tables which we have not seen in any other work on this subject.

The "Blacksmith and Wheelwright" appears as a souvenir number in its January issue, this being the 20th anniversary of its first publication. It is the reliable paper for the blacksmith and wheelwright trades and has always enjoyed a high position, won by reliability and merit.

The Railroad Officials' Diary for 1900. Issued by the "Railroad Car Journal," New York. This is an attractive and convenient diary with a whole 6 by 9 inch page for each day of the year. It is bound in flexible leather. The fly leaves at the front and back give a list of railroad technical associations with the dates of meetings, statistics of railroads and a list of the names of leased roads. Copies will be sent to railroad officers on application.

A brochure has just been issued by the W. Dewees Wood Co., McKeesport, Pa., which is one of the best productions of the kind that we have seen. It combines an account of the inception and growth of this concern, and the method of manufacture of its product in such an artistic and tasteful way as to compel the attention of one into whose hands it falls. It is the work of an adept in plan and execution. The text and engravings trace the history of the enterprise of this successful concern and follow the process of manufacture from the preparation of the charcoal and the selection of the iron, to the finished plates of patent, planished or color smooth black sheet iron, for which these works are famous. The pamphlet contains tables of the iron and steel plate and sheet gauges.

From the literary point of view, the leading feature of the January magazine number of "The Outlook" is the first installment of Mr. Hamilton W. Mabie's "William Shakespeare: Poet, Dramatist, and Man." In this series of articles, which will extend throughout the year in the monthly magazine numbers, Mr. Mabie will offer, not a formal biography, but an attempt to realize the poet and dramatist as a great Englishman, to approach him through the atmosphere of his own age, to set him distinctly in his own time, to bring about him his brilliant contemporaries, and to exhibit him as a typical man in a great epoch. The first installment deals with "The Forerunners of Shakespeare," and is illustrated with portraits, curious representations of the ancient street pageants, miracle plays, and dumb shows; for the entire series there has been gathered a great mass of illustrative material of value and beauty.

Brooks Locomotive Works Catalogue.—This volume of 336 pages is a very creditable publication in every respect. It brings together in a convenient and comprehensive form a large number of locomotives of different types built by them, giving the leading dimensions and capacities. These are illustrated by excellent full-page half-tone engravings and opposite each is the corresponding table of information. Each description has a code word. The book includes the Brooks standard specifications, a history and description of the works, a description of the Brooks design of piston valves, and of the Brooks system of construction of two and four-cylinder compound locomotives. The volume closes with convenient tables of tractive power, piston speed, mean available pressures, revolutions of driving wheels, train resistance and a cipher code. These tables are of wide range and they will cause a great demand for the book aside from its value as a record of construction and as a basis for ordering. The paper, printing and binding are excellent throughout.

EQUIPMENT AND MANUFACTURING NOTES.

The Magnolia Metal Co. have opened a branch office in room 421 Austell Building, Atlanta, Ga. This step is made necessary by increasing business. They are also about to open offices in St. Louis, San Francisco and Philadelphia.

Simplex bolsters have been specified for the construction of 200 box cars building for the Louisville, Evansville & St. Louis, at the works of the Barney & Smith Car Company, Dayton, Ohio.

The Powers Regulator Co. are entering the railroad field to provide apparatus for regulating the temperature of steam-heated passenger cars. They have secured the services of Mr. Charles F. Pierce, who is well known in connection with the Monarch Brake Beam Co. He will have offices in New York and Chicago and will take charge of the railroad department.

The Cling-Surface Mfg. Co., Buffalo, N. Y., have established a New York City branch office at 205 Postal Building, 253 Broadway, to facilitate handling their increasing business. They have also issued a booklet of pictures of belts running slack after using "Cling-Surface," which, from the point of view of past tight belt teaching, is sensational. The demand for "Cling-Surface" is increasing among the railroads and a number of repeated orders have been placed.

The Star Brass Manufacturing Co.'s new catalogue for 1900 contains illustrated descriptions of a very large line of railroad and steam plant specialties which are far too numerous to be even mentioned in detail. The most important are non-corrosive pressure and vacuum gauges, revolution counters, engine registers, locomotive and marine clocks, steam engine indicators, whistles, water gauges, gauge cocks, Siebert lubricators, oil cups, safety valves, water and cylinder relief valves and metallic specialties for cars and locomotives, including lamps and package racks for cars. The main office and works are at 108 East Dedham St., Boston, Mass.

Mr. Charles A. Moore, of Manning, Maxwell & Moore, sailed on the steamship Columbia of the Hamburgh American line January 9, for Mediterranean ports and Egypt. Mr. Moore is accompanied by his family and the trip is said to be purely one of rest and recreation, and no business is to be connected with it. It is doubtful if a man of Mr. Moore's prominence and individuality could be deterred, while in some of the important continental countries, from visiting the many famous manufactories, iron works and machine shops, and incidentally talking business. We shall probably see some effects of this trip upon the large business interests directed by Mr. Moore.

The New York Air Compressor Company's new shops at Arlington, N. J., commenced operation in all departments but the foundry on January 2, and the company expects to have its foundry at work on February 1. Although organized but a little over sixty days, the sales record of this company is remarkable, orders having been placed with it sufficient to tax its capacity for three months. Plans have been made to double the shop equipment at once, and the plant will be operated day and night until this is done. This company reports sales of over ten air compressors in ten days. These include a large duplex compressor for Japan and four compressors of twelve hundred cubic feet capacity for the Pennsylvania Railroad.

The annual meeting of the Pressed Steel Car Co. was held January 9. The president's report showed that the amount of business for the year 1899 was $13,965,572. This consisted of 9,264 cars, 127,656 bolsters and 50,926 truck frames. The money value of the orders on the books at the first of this year was $16,596,863, which is more than the total for 1899. The net earnings for 1899 were $2,237,104, out of which a 7 per cent. dividend amounting to $875,000 was paid on the preferred stock. A 6 per cent. dividend, amounting to $750,000, has been declared on the common stock; this is payable quarterly during the present year. In addition to these dividends, the sum of $612,103 has been added to the working capital of the company. The orders referred to are to be completed in June, and the present capacity of the works is 100 cars per day. The common stock has earned 11 per cent., in addition to the dividend of $875,000 on the preferred stock, and at this rate the common stock ought to earn over 20 per cent. after providing for dividends on the preferred stock for the year 1900.

An exceedingly convenient gauge for wheels, axles and brake shoes is manufactured and sold by the Youngstown Specialty Mfg. Co. of Youngstown, Ohio. It is designed for the use of car inspectors, car repairers, foremen of engines and others concerned with car and engine trucks. The gauge combines calipers for journals, used without removing the oil boxes (an index finger gives the diameter at a glance), with a gauge for slid flat wheels, one for sharp flanges, one for broken flanges, for worn treads of wheels, for vertical wear of flanges, and for measurement of brake shoes to determine when they are worn to the limit. The gauge is of steel, 1/16 in. thick, and adapted to carrying in the vest pocket. It is made to M. C. B. standard dimensions throughout and is a practical and convenient tool, valuable as a protection to the inspector and repairer as well as to the company employing them. The price is $1, by mail. The gauge was designed and patented by Walter Brainard, of the Lake Shore, Michigan Southern and the Pittsburgh & Lake Erie railroads.

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CONTENTS.

THE WESTINGHOUSE-PARSONS STEAM TURBINE.

Remarkable Steam Economy With Wide Range of Load.

Power House of the Westinghouse Air Brake Co.

The Westinghouse Machine Co., after a few years of experimental work, have established the steam turbine in this country upon a basis which will surprise those who have not been watching it.

It has recently been installed in the power plant of the Westinghouse Air Brake Co. at Wilmerding, and in a short time it will be depended upon entirely for the motive power and lighting of these works. This installation is in itself an expression of confidence in these machines, the effect of which will not be lost.

In 1896 the patent rights in the Parsons Steam Turbine for the United States were acquired by the Westinghouse Machine Co., and this concern has been engaged upon a development which has resulted in marked improvements over the original machines in England. The assistance of Mr. Francis Hodgkinson, an engineer who was identified with the development of the Parsons Turbine in England, was secured, and he is now in charge of the turbine department of this company at Pittsburgh. Work is now well advanced on a 2,500 h. p. turbine, Fig. 7, for the United Light & Power Co., of New York. It will be the largest unit of this kind ever attempted, and will run at 1,200 revolutions per minute under a steam pressure of 150 lbs. The spindle of this machine, complete with its vanes, weighs 28,000 lbs. The largest diameter of the spindle is 6 ft. and while this is a colossal turbine, it is a small engine for such power capacity. The capacity of the direct connected generator will be 1,500 kw. and the ultimate capacity of the turbine about 3,000 h. p.

The steam turbine is, in a sense, a return to the principles of the earliest steam engine, in which the energy of the steam was transformed into work by making use of the impact and reaction due to its velocity. There is no loss from condensation and re-evaporation, or loss by reason of the same passages being used alternately for live and exhaust steam, as is the case with reciprocating engines. The work is taken out of the steam progressively, and the temperature falls gradually and continuously from the admission to the condenser. In these features it has advantages over other steam engines. The continuous action, absence of dead centers and the consequent mechanical complications, together with the avoidance of suddenly applied and instantly reversed stresses, are advantages the full purport of which is not yet fully appreciated. The economy of the turbine and its wide range of economical load will be mentioned later in connection with Fig. 6.

At the Westinghouse Air Brake Co.'s shops, three 500 h. p. turbines are direct connected to 300 kw. generators and are furnishing power for driving and lighting the entire plant by means of a newly installed electrical distribution system, which we shall describe. The turbines are comfortably located on a floor space 20 x 25 ft., the bed plate of each machine measures 16 ft. 7 in. x 4 ft. 3 in., and the whole plant producing 1,500 h. p. and including three turbo-generators, two 10 h. p. exciter engines and generators, two pairs of condensers and air pumps, and the switchboard occupies a space of 29 x 36 ft. The turbines are designed for condensing the exhaust and for this purpose a novel air pump design was developed. This consists of a combination of a pair of jet condensers and compound air pumps, in which the water and air are handled in separate cylinders. The condenser pumps are operated by a 50 h. p. belted motor, this being the cheapest and most convenient method in this case. The vacuum is often as high as 28 ins., while the average barometer is 29.25 in Pittsburg. The delivery water is only a fraction of a degree different in temperature from that of the steam in the condenser. The operation of these engines, considered thermally, is most impressive; for example, the temperature of the boiler steam entering the turbines is about 350 degrees, and yet at a point about 4 ft. from where the steam enters the cylinder, the exhaust pipe is cool enough to hold ones hand upon very comfortably. This is a revelation to those who notice it for the first time. The exhaust temperature at the time of the writer's visit was 102 degrees, while the temperature of the discharge water from the condenser was 101 degrees. This is a remarkable exhibition of the transformation of heat into work. There cannot be much condensation, or the close fitting parts would not operate so smoothly at these high speeds.

The turbines are of the multiple expansion type, running at 3,600 rev. per minute, with 125 lbs. boiler pressure. There is no gearing for reducing the speed, and this equipment is in marked contrast with the DeLaval system, which is characterized by some 13,000 revolutions in a turbine of about this capacity, reduced by gearing to 1,050 rev. of the generator and working at 150 atmospheres steam pressure. The DeLaval system makes use of flexible shafts, which break, gearing which wears out and other unpractical conditions, which are out of the question outside of the laboratory of the inventor.

In the turbines which we are describing a single bed plate carries a unit of one turbine and its generator. A cast iron base supports a cylinder of varying internal diameters, in the interior of which numerous rows of guide blades or curved vanes are secured. The exterior contour in the engraving gives an idea of the construction. A shaft carrying drums of correspondingly varying diameters, with similar rows of blades secured radially and spaced to fit between the stationary rows, constitutes the rotary part, which corresponds to the wheel of the turbine water wheel. The shape of these blades represents a great deal of study and experiment. The stationary rows of blades serve to guide the steam in the proper direction for doing work upon the movable ones. The steam enters the small end of the cylinder and in expanding through the first set of guide blades, its energy is transformed into velocity, and in impinging against the next set, which are on the spindle, it gives up nearly all of its velocity. In expanding through the moving blades the steam again attains a velocity which by reacting upon the blades gives up energy to become work. Each succeeding row of blades increases in size, corresponding to the increased volume of the steam. The cylinders are di-

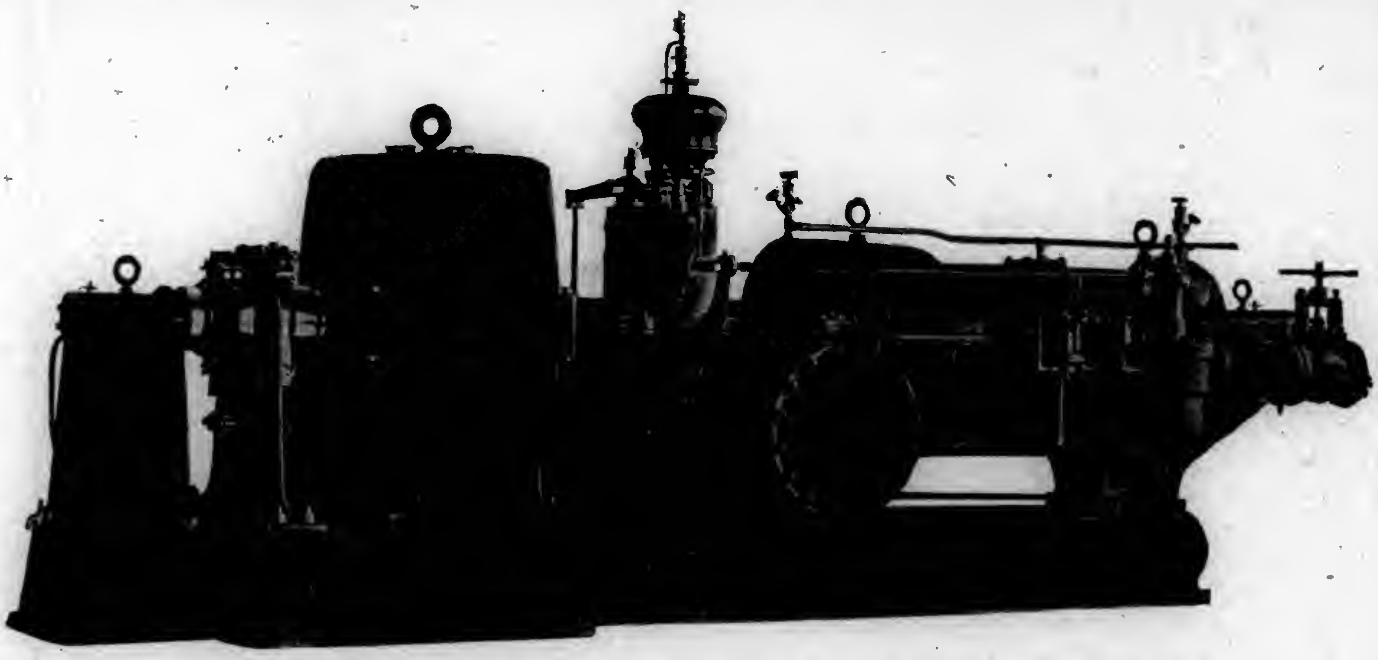


Fig. 1.—Side View of Turbine and Generator Showing Governor Connections to the Steam Valve.

Fig. 2.—Rear View of Three Turbine Units.

Westinghouse-Parsons Steam Turbine at the Works of The Westinghouse Air Brake Co.

vided into three steps, in each of which there are several grades of expansion. The total expansion ratio is about 1 to 96.

The high speeds necessitate careful balancing and this extends also to the armature of the generator. This has been accomplished so well that no foundation is required (even for the large machine shown in Fig. 7) except a brick pier to support so much dead weight. There are no holding down bolts. Lubrication in this case is most important, an oil pump, shown in Fig. 5, driven by a worm mounted on the sleeve coupling between the turbine and the generator, circulates oil into all the bearings under a light pressure and a cooling system is provided in order to cool the oil on account of the heat absorbed from the steam. The balancing is of course not absolutely perfect, and the bearings are made to provide for a slight motion of the shaft. The bearings are made with concentric tubes of brass surrounding the journal, and are put together with easy fits and spaces for oil between them. This forms a self-centering cushion, which has a tendency to reduce the vibrations of the shaft. The tubes show no signs of wear, because of the films of oil between them, the oil forming the real bearing. The

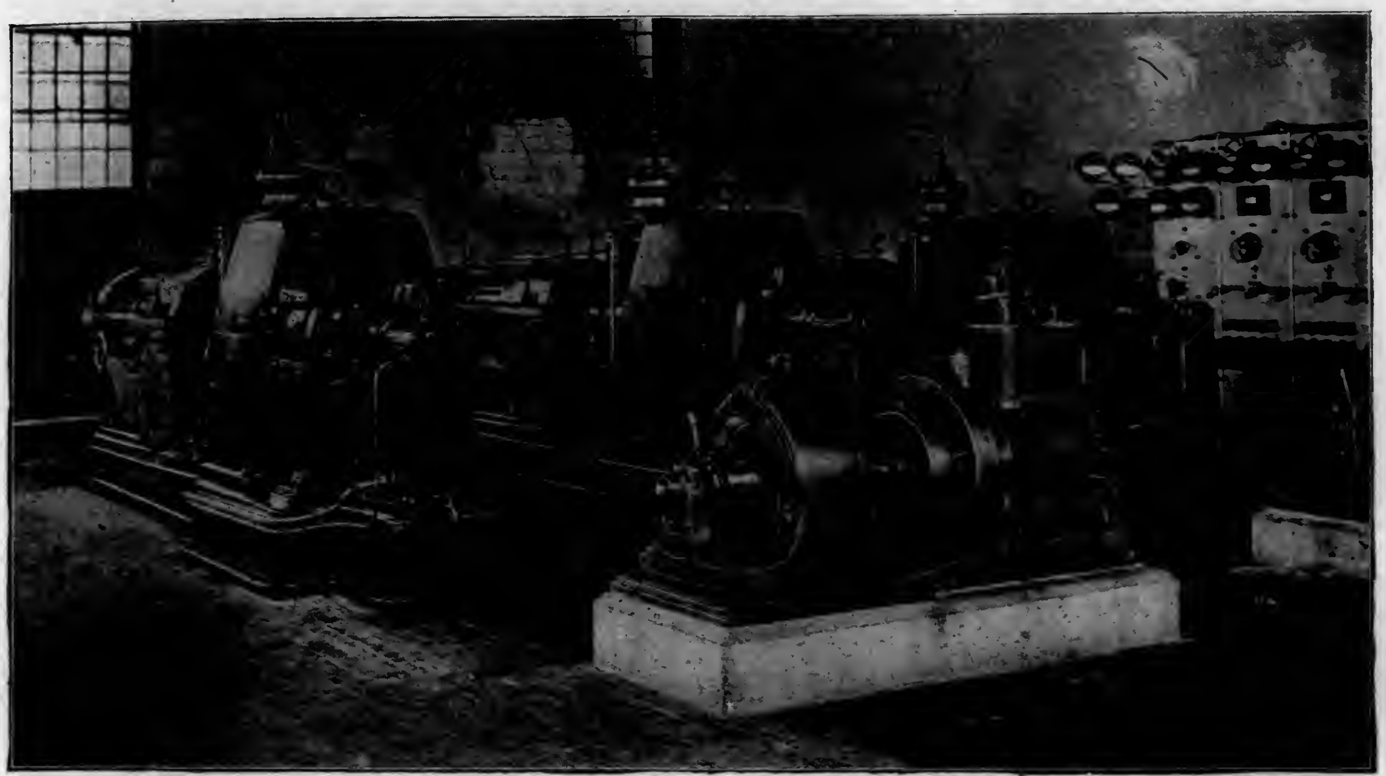


Fig. 3.—End View of Three Units, Showing Comparison with 10 Horse Power Exciter Unit.

Fig. 4.—View in Power Station Showing Generators, Exciter Units and Switchboard.

Westinghouse-Parsons Steam Turbine at the Works of The Westinghouse Air Brake Co.

shaft is not rigidly confined, as in the ordinary tight-fitting bearing, and this slight latitude of motion of the shaft is an important element in the working of this machine. This motion takes care of the gyration which the most perfect balancing that is practicable does not eliminate.

To counteract the end thrust on the spindle, due to the impact of the steam on the blades, the shaft is held in equilibrium by means of three balancing discs at the steam end of the spindle contained in the turbine casing and marked in Fig. 5. These are made steam tight with the cylinder, and the diameter of each disc is made equal to the mean diameter of the corresponding drum carrying the blades. These disc chambers are connected by cores through the cylinder casting, with the spaces occupied by the corresponding drums. In this way the shaft floats endwise as it may, but it has no thrust. The steam cylinder has a by-pass valve, Fig. 5, which admits steam from a cored passage leading from the entrance port to the second drum. This may be used to increase the power of the machine when a heavy overload is to be carried (even to 60% overload), or it may be used to increase the power in case the

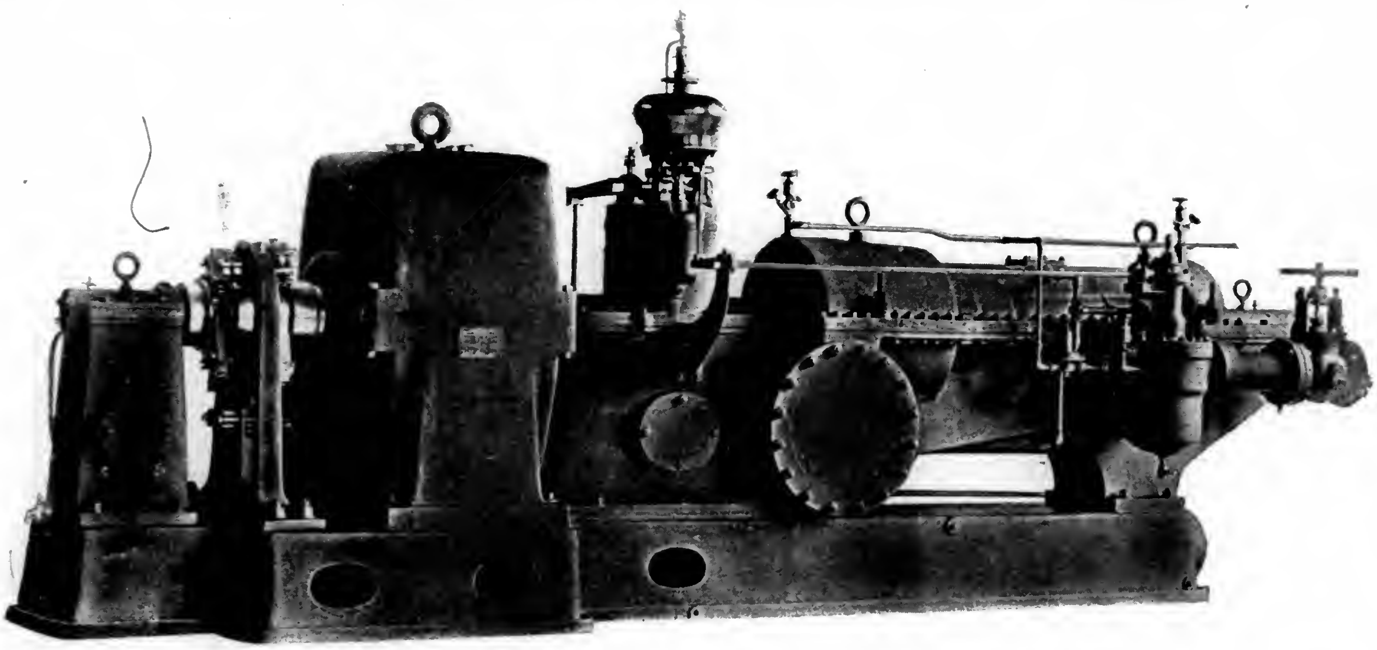


Fig. 1.—Side View of Turbine and Generator Showing Governor Connections to the Steam Valve.

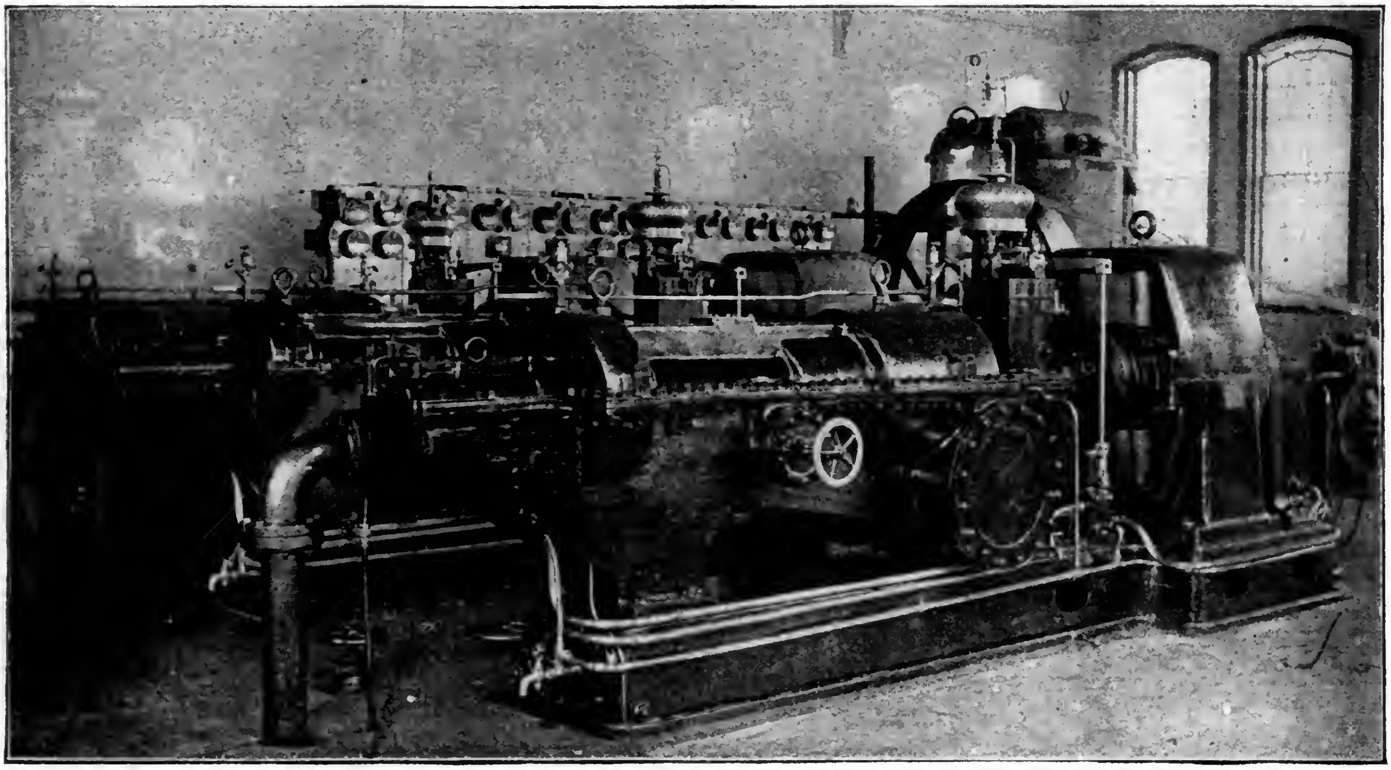


Fig. 2.—Rear View of Three Turbine Units.

Westinghouse-Parsons Steam Turbine at the Works of The Westinghouse Air Brake Co.

vided into three steps, in each of which there are several grades of expansion. The total expansion ratio is about 1 to 96.

The high speeds necessitate careful balancing and this extends also to the armature of the generator. This has been accomplished so well that no foundation is required (even for the large machine shown in Fig. 7) except a brick pier to support so much dead weight. There are no holding down bolts. Lubrication in this case is most important, an oil pump, shown in Fig. 5, driven by a worm mounted on the sleeve coupling between the turbine and the generator, circulates oil into all the bearings under a light pressure and a cooling system is provided in order to cool the oil on account of the heat absorbed from the steam. The balancing is of course not absolutely perfect, and the bearings are made to provide for a slight motion of the shaft. The bearings are made with concentric tubes of brass surrounding the journal, and are put together with easy fits and spaces for oil between them. This forms a self-centering cushion, which has a tendency to reduce the vibrations of the shaft. The tubes show no signs of wear, because of the films of oil between them, the oil forming the real bearing. The

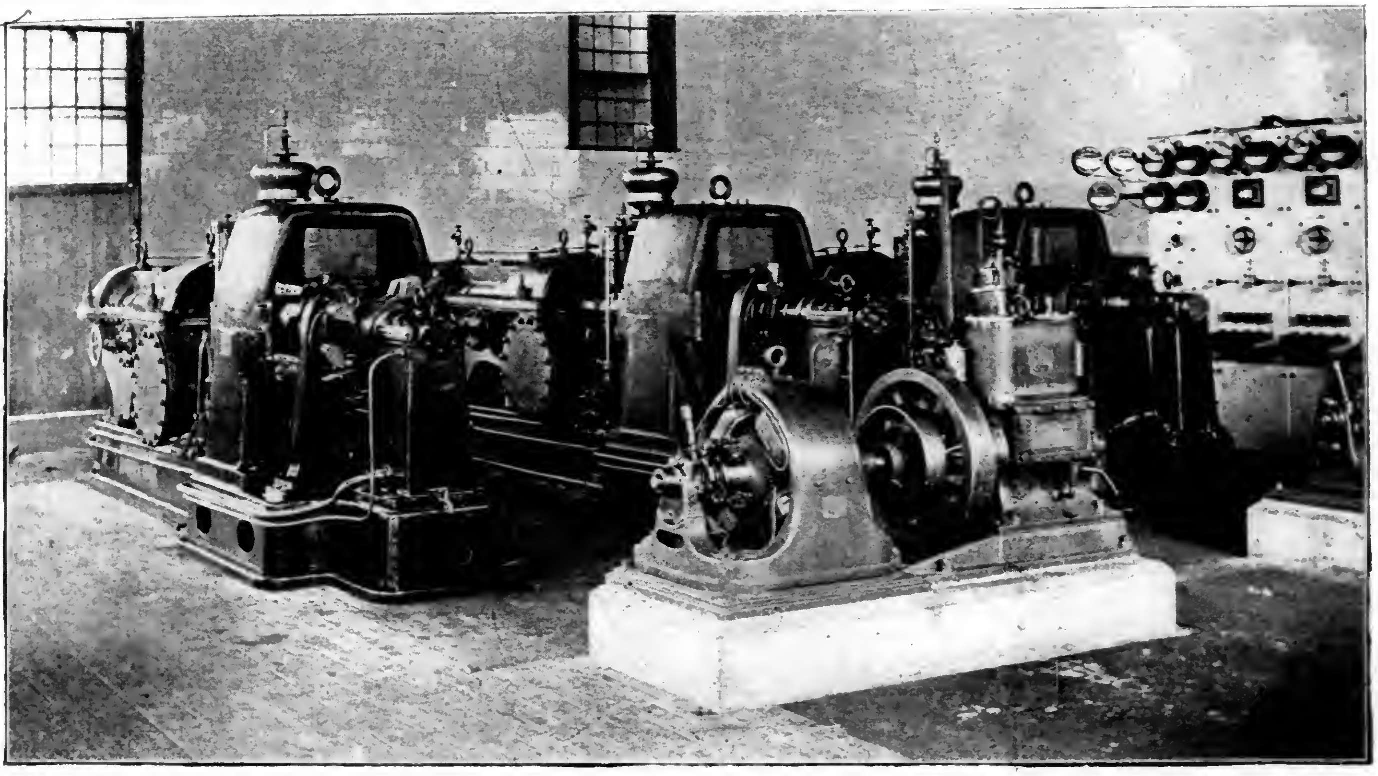


Fig. 3.—End View of Three Units, Showing Comparison with 10 Horse Power Exciter Unit.

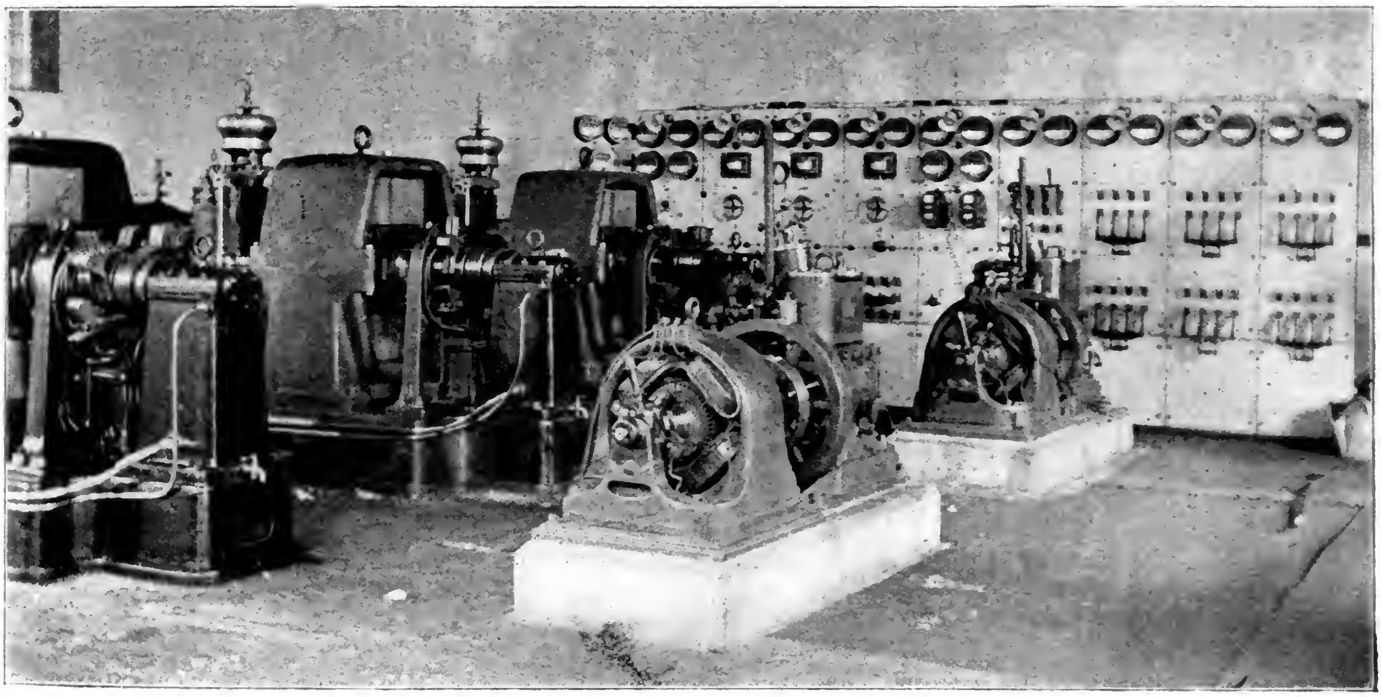


Fig. 4.—View in Power Station Showing Generators, Exciter Units and Switchboard.

Westinghouse-Parsons Steam Turbine at the Works of The Westinghouse Air Brake Co.

shaft is not rigidly confined, as in the ordinary tight-fitting bearing, and this slight latitude of motion of the shaft is an important element in the working of this machine. This motion takes care of the gyration which the most perfect balancing that is practicable does not eliminate.

To counteract the end thrust on the spindle, due to the impact of the steam on the blades, the shaft is held in equilibrium by means of three balancing discs at the steam end of the spindle contained in the turbine casing and marked in Fig. 5. These are made steam tight with the cylinder, and the diameter of each disc is made equal to the mean diameter of the corresponding drum carrying the blades. These disc chambers are connected by cores through the cylinder casting, with the spaces occupied by the corresponding drums. In this way the shaft floats endwise as it may, but it has no thrust. The steam cylinder has a by-pass valve, Fig. 5, which admits steam from a cored passage leading from the entrance port to the second drum. This may be used to increase the power of the machine when a heavy overload is to be carried (even to 60% overload), or it may be used to increase the power in case the

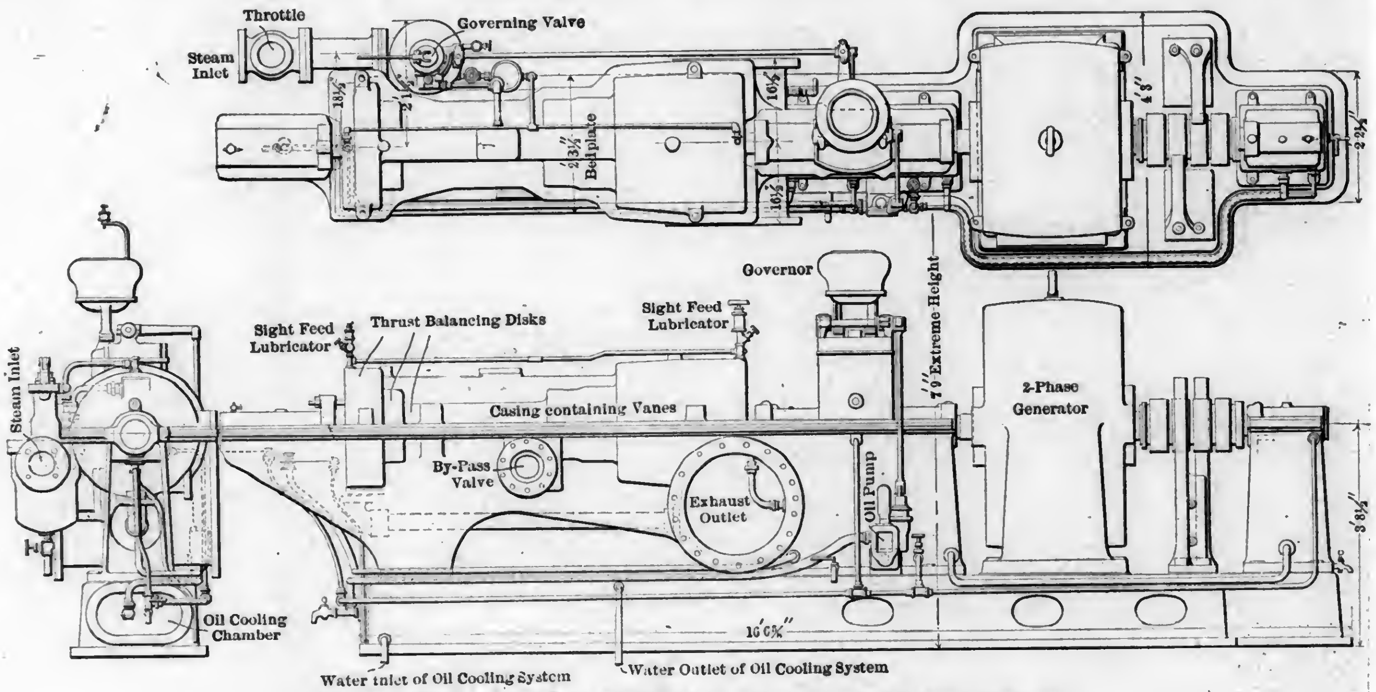


Fig. 5.—300 Kw. Unit as Erected at Westinghouse Air Brake Works.

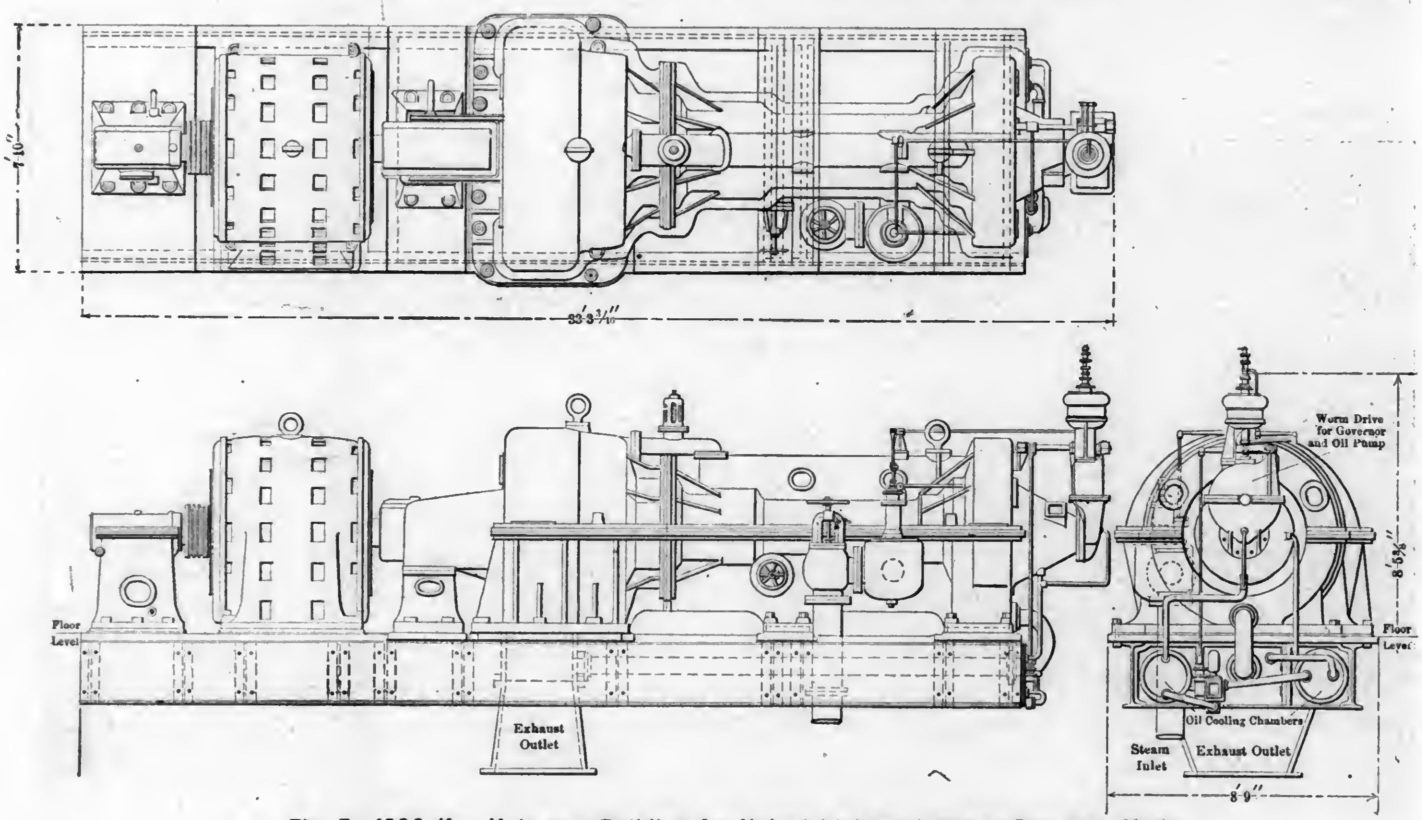


Fig. 7.—1500 Kw. Unit now Building for United Light and Power Co., New York.

condenser is inoperative, for any reason. This increases power at the expense of efficiency, however.

This is the first time that direct connected alternating current generators have been successfully driven by turbines for multiple connection. The speed regulation is beautiful, and it is accomplished without the least stress, jerk or strain upon anything connected with the machinery. The governor, which is of the fly-ball type, controls the duration of the intermittent admission of steam. Lever and shaft connections from an eccentric, driven by a worm on the main shaft (under the governor) already referred to, operate a little piston valve, which controls the larger main admission valve, which is also of the piston type and located as shown in Fig. 5. The central position of the governor gives continuous admission and this is the full load condition. The governor, by raising or lowering the fulcrum of the lever, but without changing the leverage, changes the plane of motion without changing the stroke of the little piston valve and thereby determines the duration of the opening of the main valve. At full load the valve is open all the time, and at very light loads it is closed most of the time. The intermitent admission is to insure working with high pressure steam, whatever the load, and to prevent the losses of wire drawing.

The governors are extremely sensitive, and may be adjusted to run within a small fraction of 1% variation between no load and full load. But in this particular case, on account of the

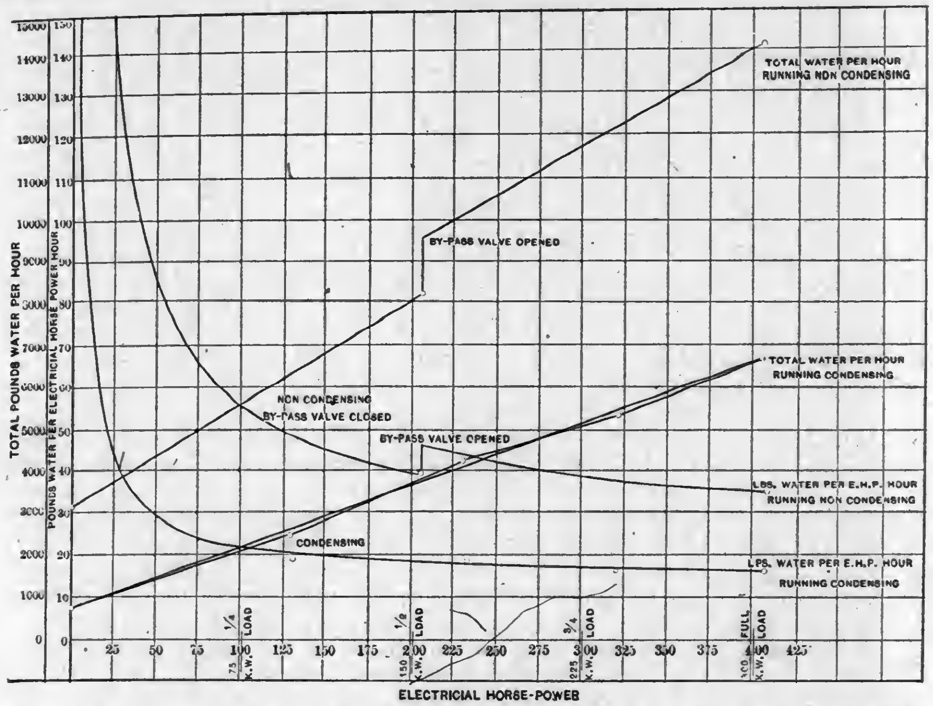


Fig. 6.—Test of 300 Kw. Unit, Showing Remarkable Steam Economy Over Wide Range of Load.

relatively as good results as these turbines running condensing. The diagram also shows the effect of opening the by-pass valve.

The half-tone engravings, Figs. 1 to 4, inclusive, were made from photographs taken in the power station. Fig. 1 shows a side view of one of the turbine sets. One of the large exhaust openings is seen in this view, covered by a plate. There are two such openings, one on each side of the machine. This view also shows the governor connection to the admission or governing valve and the throttle valve appears at the extreme right. A rear view of the three turbines is given in Fig. 2. The generators are at the right and the switchboard appears over the turbine. A comparison between the size of the 10 h. p. exciter unit and the turbines may be made in Fig. 3. There are two of these exciter units driven by Westinghouse engines. A view of the generator ends of the turbine units is given in Fig. 4, which also shows the switchboard.

generators having to run in multiple, it is desirable to have a considerably greater variation, in order that each generator may take its proper share of the load. The speed of the turbines and the inertia of the rotating part are so great, while the friction is so small, that the turbine will continue running for twenty minutes after steam is shut off. Under these conditions, change of speed during one revolution is absolutely negligible. There is an adjustment provided on the governor by means of which the speed may be varied within wide limits, while the turbines are running. This enables the generators to be brought into synchronism, and the loads divided with the greatest ease.

The generators, made by the Westinghouse Electric & Mfg. Co., are of the bi-polar type, giving a two-phase alternating current of 440 volts with 7,200 alternations per minute, and having a capacity of 300 kw. each. They appear absurdly small for such capacities until the high speed is considered. Very elaborate tests were made at the works of the builders, resulting in the very remarkable curves of efficiency shown by the diagram, Fig. 6. The long horizontal portion of the steam consumption line is wonderful when one considers that this machine of only 500 h. p. will work on any load from about one-quarter load up to a large overload, with greater economy than most of the highest grades of reciprocating engines of many times this capacity, even when taken at their best. The following condensed statement shows the economy:

Full load, 16.4 lbs. steam per electrical h. p. per hour.
¾ " 17 " " " " " "
½ " 18.2 " " " " " "
¼ " 22 " " " " " "
Running light, 750 lbs. steam per hour.

We feel perfectly safe in saying that these results have never been approached before. It is impossible to measure the indicated and probably also the brake h. p. of these turbines, but it is estimated that they are working, at full load, on 13.2 lbs. of steam per indicated h. p. per hour, using this term in its understood sense. The turbine has, therefore, scored a remarkable triumph in this its first appearance in this country, in a place of responsibility in driving an important plant.

It should be understood that these particular turbines have been designed to give their best results when running condensing, hence the comparatively inferior results when running non-condensing, which are shown in the economy curves. A turbine designed essentially for non-condensing would give

The shops of the air brake company are now equipped with a large number of two-phase induction motors, made by the Westinghouse Electric & Mfg. Co., and the entire installation has been made with commendable thoroughness, which includes the arrangement and appointments of the power station. The wires and steam pipes are all under the floor level. This distribution system will be made the subject of another article.

We are indebted to Mr. E. E. Keller, Vice-President and General Manager of the Westinghouse Machine Co., for the photographs and drawings accompanying this description.

The White Pass & Yukon Railway, the interesting new line in Alaska, has 20 miles now in operation, 16 of which are on a grade of very nearly 4 per cent. In spite of the difficulties which this hill causes, the operation has been free from serious accidents since its opening a year ago last July. During the month of September last, nearly 1,000,000 pounds of freight were hauled, and the average number of cars available was but 50.

A severe test of cast steel bolsters, made by the American Steel Foundry Co., of St. Louis, described in a recent issue of the "Railway Age," is noteworthy. In a rear-end collision on the Chicago & Alton the engine of the second train turned the caboose of the leading train aside, and in the mix-up this locomotive was carried up on top of a loaded coal car of 80,000 pounds capacity and was towed to the shops on the car. The weight of the engine was about 50 tons, and the total load of the car including the coal was about 90 tons, this weight, of course, came upon the bolsters, and they met the severe test without breaking down or being damaged in any way. This accident substantiates the strong claims made for these bolsters in an unmistakable way.

The three new battleship designs, the "Georgia," "New Jersey" and "Pennsylvania," which have been agreed upon by the Naval Board of Construction, will be superior in speed and fighting power to any warships yet built or planned by any other nation. Their displacement will be about 14,000 tons, speed 19 knots or more, bunker capacity 2,000 tons, and steaming radius 7,000 miles, which is sufficient to cross the Atlantic and come back. There will be two 12-inch and two 8-inch long guns for smokeless powder in each of two (fore and aft) superimposed turrets, and also twelve 6-inch rapid-fires. The armor is to be the "Krupp" and the cost will be about $7,000,000 each when fully equipped.

LOCOMOTIVE DESIGN.*

By F. J. Cole, Mechanical Engineer Rogers Locomotive Works.

Equalization of Weight.

It is very desirable that the weights borne by the driving wheels of a locomotive should be as nearly alike as possible, and that each wheel should bear its due proportion of the total load. If an engine with three pairs of coupled wheels has 90,000 pounds on the drivers, the weight on each pair should be 30,000 pounds, or one-third of the total load. Where the weight is thus uniformly distributed the destructive effect on the rails, bridges, etc., for any given class of engine may be considered as most favorable, and apart from the size and type, the best possible distribution that could be made. If on the other hand the weight was 60,000 pounds on one pair and 15,000 pounds on each of the other pairs, the arrangement might very justly be considered the most unfavorable and probably the worst that could be made.

The equal distribution of weight among the 2, 3, 4 or 5 pairs of drivers varying according to the type, has always been carefully considered in locomotive design, and the numerous instances of overloads on some one pair of wheels, that can be seen in existing engines should be viewed as examples of faulty design and not as inherent defects in certain types which cannot be remedied.

If a beam (Fig. 1) be supported at both ends and uniformly

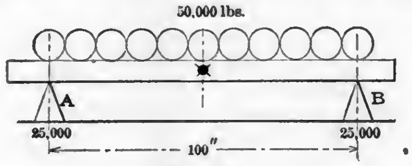


Fig. 1

loaded with a weight of 50,000 pounds, including the beam, it is evident that the supports A and B will each bear one-half the total weight or 25,000 pounds. If, however, the support A be moved toward the center, as in Fig 2, one-quarter of the original distance, so that the centers of support are 75 inches apart instead of 100 inches, the load on A is increased to 33,334 pounds, and decreased on B to 16,666 pounds. To find out the weight on A or B for any position of A,

Let W = total load.

W_1 = load on support A.

W_2 = load on support B.

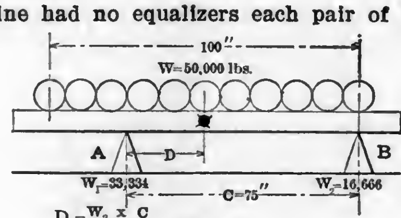
C = distance between supports.

D = distance from A to center of gravity.

$$\text{Then } D = \frac{W_2 \times C}{W}.$$

$$W_2 = \frac{D \times W}{C}.$$

If an engine had no equalizers each pair of wheels would



$D = \frac{W_2 \times C}{W}$ Fig. 2

$W_2 = \frac{D \times W}{C}$

carry that proportion of the entire load which is due to the position of the longitudinal center of gravity of the structure carried by the driving springs. The individual wheel loads would also vary according to the spacing of the wheels and the amount the load overhung the front or back wheels. In Fig. 3 is shown an engine without equalizers, the center of gravity of the boiler and attachment being at A. Had it been directly over the middle wheel the total weight would be equally dis-

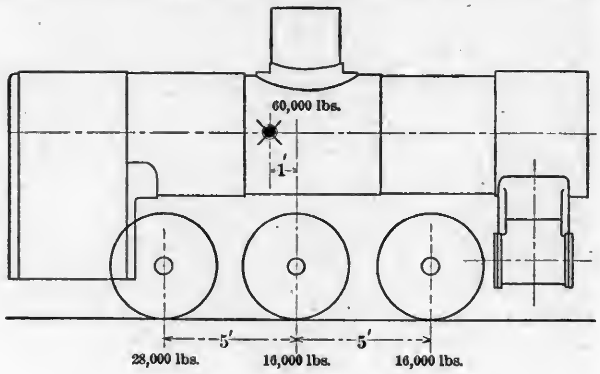


Fig. 3

tributed among the three pairs of wheels or 20,000 pounds for each pair. Being located one foot back of the middle wheel the distribution of weight is materially altered. It is increased to 28,000 pounds on the rear wheel and decreased on the front and middle pair to 16,000 pounds each. If the center of gravity be moved backward until it is directly over the rear wheels the entire weight of 60,000 pounds would then be carried on this pair and none on the front and middle wheels. In like manner if the center of gravity be moved forward until it is directly over the front wheels, the entire weight will be borne by those wheels and none on the middle or back wheels, so that within the limits of the wheel base (which is ten feet in this case) the back or front wheels may be made to bear the whole load according as the center of gravity is moved in relation to the wheels. Therefore, to get an equal distribution of weight on the driving wheels of an engine in which the springs are not connected to one another by means of equalizing levers, it is necessary that the center of gravity of the supported structure be accurately located to suit the arrangement of wheels, otherwise the weight on each pair of wheels will be determined by a chance position of the center of gravity.

This is best shown in its simplest form by a 4-wheeled switching engine, Fig. 4. The usual arrangement of the springs

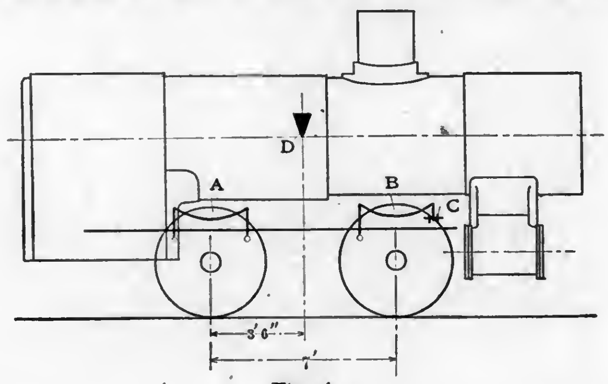


Fig. 4

is to fasten the ends of the rear spring A by means of its hangers to the frames; the back end of the front spring B is similarly fastened to the frame, while the front ends at C are connected transversely by means of a cross equalizer. This supports the engine at three points, namely: the rear axle or two back springs, and the front axle or a point midway between the center of the cross equalizer and the rear hanger of the front spring. It is evident that if the center of gravity of the boiler and its attachments is not directly upon the vertical line D between the two pairs of wheels, the weight will not be equally distributed.

In this type of engine, whether it carries its own fuel and water, or is provided with a separate tender, the center of gravity must be located midway between the wheels to obtain an equal load on both pairs of wheels. Longitudinal equalizing levers connecting the springs together sideways are not ordinarily used in this class of engine, owing to the increased pitching fore and aft which would result from their use and the

* For previous article see page 33.

exact balancing which would be required. If their use were permissible the arms could, of course, be made of unequal length to partially correct a faulty design.

The calculation of the center of gravity of a new engine, involves estimating or knowing the weight of each part and its distance from some assumed center. To work this out completely consumes considerable time, therefore frequently much is assumed from engines of similar build, the wheel weights of which are known. A case in point was a class of 4-wheeled switching engines with separate tenders, which were not only heavy in front but also were deficient in grate area. When more engines of the same class were required the balancing was improved by increasing the length of the firebox until the weight upon both pairs of wheels was equalized. The weight upon the front pair was decreased owing to the overhang of the addition to the firebox, with the center of the rear axle as a fulcrum, and the weight on the rear pair increased to an amount equal to the decrease on the front axle and the actual additional weight. The amount of additional firebox required was estimated and when they were built the result was not only perfectly balanced engines but the steaming qualities also were much improved. Another case was of a 6-wheel switcher, which was several thousand pounds too heavy on the front pair of wheels. One of these engines was accurately weighed so that the actual weight on each pair of wheels was known. Having this information, the amounts to add to the foot plate and to take from the front end could be readily obtained. As the back and main driving springs, Fig. 5, were connected by equalizing levers, any additional weight at C exerted a force at F equal to $\frac{W\ (A + B)}{B}$ and diminished the weight at the front axle G equal to $\frac{WA}{B}$. The extension front and front end of the frames were made as short as practicable and the effect of these changes calculated and plotted under each wheel until the decreased weights taken from the front wheels and added or partly added to the rear wheel produced the desired effect. The result was, when other engines of similar class were built that the distribution of weight was practically perfect.

In American practice it is customary to use equalizing levers, whenever practicable, to connect together the springs of the

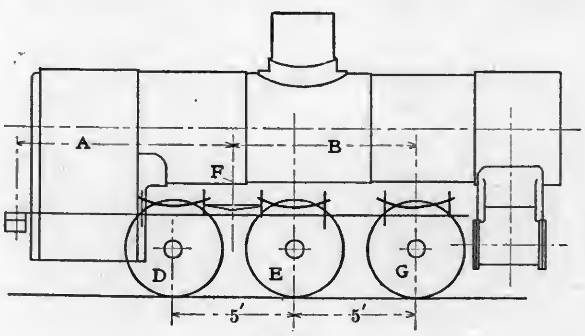


Fig. 5

different pairs of driving wheels. The principal function of an equalizing lever is to equalize the weight between two or more pairs of wheels; also to allow a maximum amount of vertical motion in any one wheel in its relation to the frame of the engine, without too great a deflection of its spring, or too great a variation of the load borne by that wheel. If the track is very uneven and an engine is run over it without equalizers, each spring must in turn deflect enough to compensate for its inequalities, and in doing so the load upon each spring is increased or decreased according to the amount the spring is deflected or released, and the load upon the springs belonging to the other pairs of wheels increased or decreased according to the undulation of the track. If, on the other hand, equalizing levers are introduced, the tension on the springs is uniformly maintained, by the levers rocking upon their centers and preserving equal wheel loads.

The arrangement of spring rigging for an American 8-wheel engine is shown in Fig. 6. In this type there is a 4-wheeled center bearing leading truck and two pairs of coupled driving wheels. The driving wheel springs are connected by means of side equalizing levers D attached to the frames by fulcrums at E. The engine is, therefore, supported at three points, namely, the truck center in front and the two equalizer lever fulcrums E, one on each side in the rear. If the fulcrums E are located centrally between the wheels (which is the universal method) the weight supported by each driving wheel will be the same. This applies only to the parts carried by the springs and not to the parts riding directly upon the axles or crank pins. For this reason the main wheels when weighed

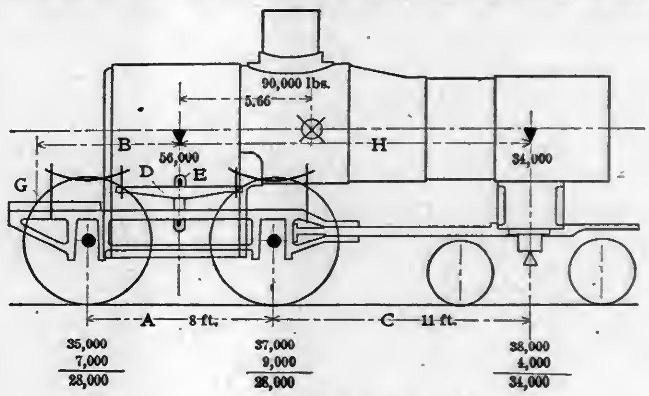


Fig. 6

will always be heavier than the back wheels, owing to the weight of the eccentrics and straps, part of the eccentric rods, the back ends of the main rods, and the additional counterbalance required. In this type of engine when the firebox is between the two driving axles as in Fig. 6, the average weight on the truck is about 36 per cent. and 64 per cent. on the driving wheels and when the firebox extends over the rear axle, 32 per cent. on the truck and 68 per cent. on the driving wheels. Owing to the excessive weight on the truck, when the firebox is between the axles, a very heavy footplate is often used to increase the weight on the driving wheels and decrease it on the truck wheels. The effect of a weight placed at G is to increase the weight on the drivers to an amount greater than the weight itself. This may be explained by reference to Fig. 6. Suppose 1,000 pounds is added to the foot plate at G, then the increase of weight on the drivers at E will be equal to $\frac{1{,}000 \times (B + H)}{H}$ and the decrease on the truck to $\frac{1{,}000 \times B}{H}$.

Example: Let $B = 6$ feet, $H = 15$ feet. Then

$$\frac{1{,}000 \times (6 + 15)}{15} = 1{,}400 \text{ pounds,}$$

the increase of weight on drivers, and $\frac{1{,}000 \times 6}{15} = 400$ pounds, the decrease of weight on the truck.

The center of gravity of the weight carried by the springs is found by making a diagram of the engine like Fig. 6. Under each driving wheel and under the center of the truck, write the weight in pounds resting on the rail. From these amounts subtract in each case the weights of the wheels, axles, journal boxes, springs and saddles. For the back wheels subtract also the weights of half the parallel rods and two crank pins, and for the main wheels half the parallel rods, two crank pins and 63 per cent. of the main rods, the eccentrics and straps, and half the eccentric rods. The remainder is 28,000 pounds on each pair of drivers and 34,000 pounds on the truck, making a total of 90,000 pounds exclusive of wheels, axles, etc. The center of gravity

of the weight on the drivers is evidently at the equalizer fulcrum, E. Write 56,000 pounds at this point and 34,000 pounds at the center of the truck. The common center of gravity of the two weights is found by multiplying the weight on the truck by the distance between the weights, and dividing by the sum of the two weights; the quotient is the distance from the rear weight, E, to the longitudinal center of gravity.

Example: Distance H = 15 feet. Then $\frac{34,000 \times 15}{90,000} = 5.66.$

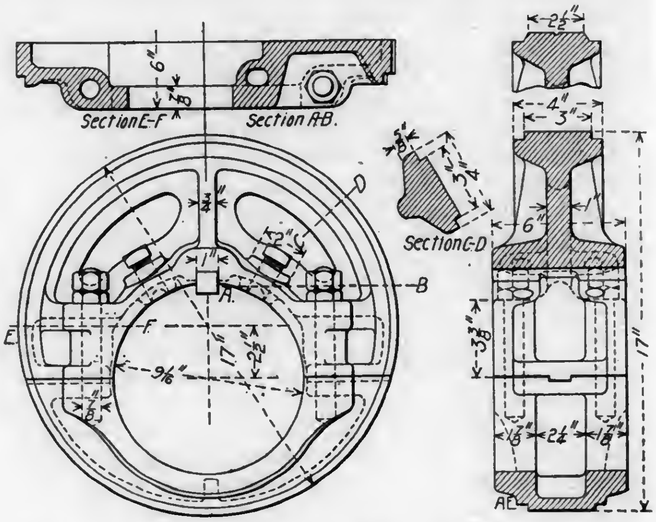
In this class of engines the weight on the truck is likely to be excessive; it is possible, however, to improve this somewhat by making the foot plate unusually heavy, and the bumper, smokebox extension, front and door as light as possible. Also by making the diameter of the boiler in front comparatively small, and the back end large, with as much wagon top as the conditions will admit.

(To be Continued.)

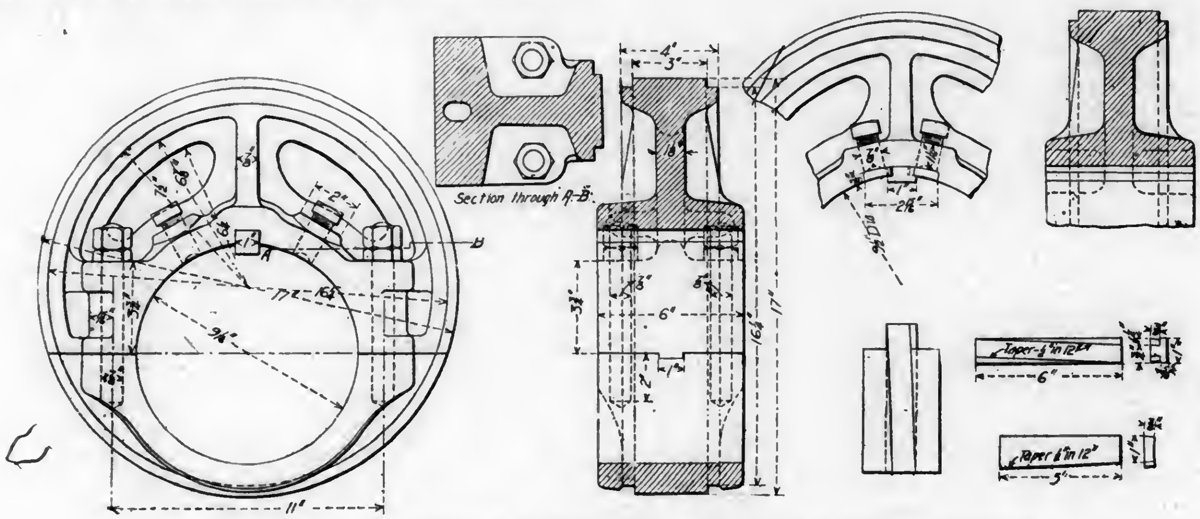
AN IMPROVEMENT IN LOCOMOTIVE ECCENTRICS.

The Brooks Locomotive Works.

One of the interesting details of the new passenger and freight locomotives built by the Brooks Locomotive Works for the Lake Shore & Michigan Southern Railway is an improvement in the construction of the eccentrics. Instead of putting in two bolts or studs to hold the halves of the eccentric together, the hub is widened out sufficiently to admit of using four of them. The design is an excellent one, which has been used by these builders on several recent orders. The engraving shows the design as applied to the Lake Shore engines, in which the hub was shortened somewhat and in which studs are used instead of bolts. The usual length of the hub is one-half inch greater than shown in the drawing. The object of this design is to prevent the eccentrics from working loose and wabbling on the axle, which is a common fault with the usual forms of split eccentrics upon powerful locomotives. It will be noted that the two halves of the eccentric are separated by a shim (No. 34 Birmingham Wire Gauge in thickness) when they are bored, in order that when bolted together upon the axle they will clamp it firmly and prevent any side motion or wabbling and at the same time be more secure against rotary displacement. It will be observed that the length of the axle fit is 6 inches. The shims which are used only in boring are removed before the eccentric is turned up, so that the outside when clamped on the axle is a true circle. This clamping device necessitates the use of four bolts or studs in order to insure perfectly true fitting of the two halves of the eccentric. The drawing shows the bearing portion of the eccentric and at once gives the impression of great strength in addition to the security of the fastening.



Design of Improved Eccentric, Showing a Large Saving in Weight by Coring.
Brooks Locomotive Works.

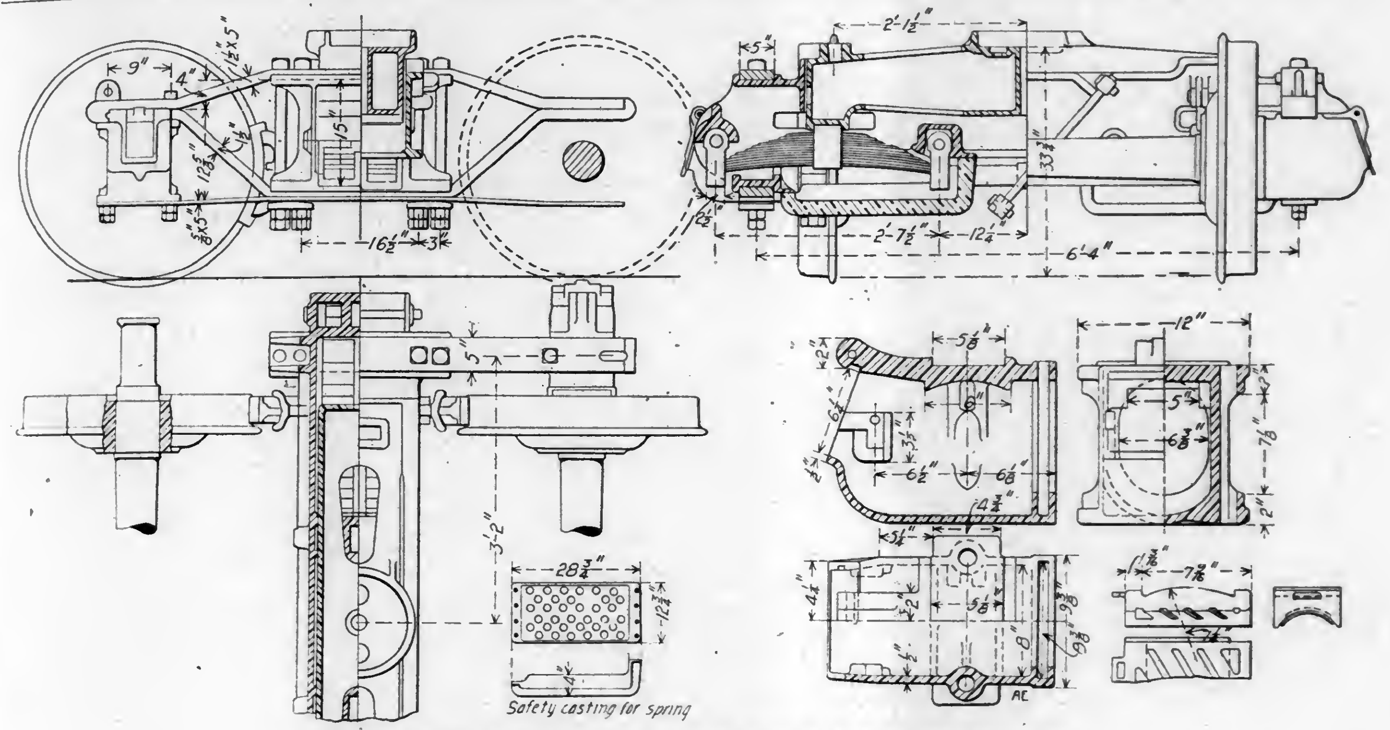


Improvement in Locomotive Eccentrics Used on New Lake Shore Locomotives.
Brooks Locomotive Works.

Two forms of set screw and key attachment are shown. In one the set screws bears directly against the axle and the key is 1 inch square in section and 6 inches in length. In the other arrangement there is a central key, a portion of which projects into the slot in the axle and the upper portion is fitted by tapered surfaces, inclined one-half inch in 12 inches, between two thin pieces, which are cut radially to fit the axle and against the tops of these the set screws bear. The tapered sides of these thin keys are cut to the exact size required after the valves are set. It is therefore possible to change the position of the eccentric upon the axle by changing the position of these keys, and by merely replacing the set screws. The movement may be ⅛ in. in either direction. Information is at hand to show that eccentrics of this type are giving excellent results in service.

The smaller engraving illustrates a later design by the Brooks Locomotive Works in which the long bearing of 6 in. on the axle is retained but with much thinner section of metal, which was done to save weight.

These are the greatest improvements in locomotive eccentrics that we have seen. This style of split eccentric is standard with the Brooks Locomotive Works for all heavy engines.



Cast-Steel Truck for Heavy Tenders, Louisville & Nashville Railroad.

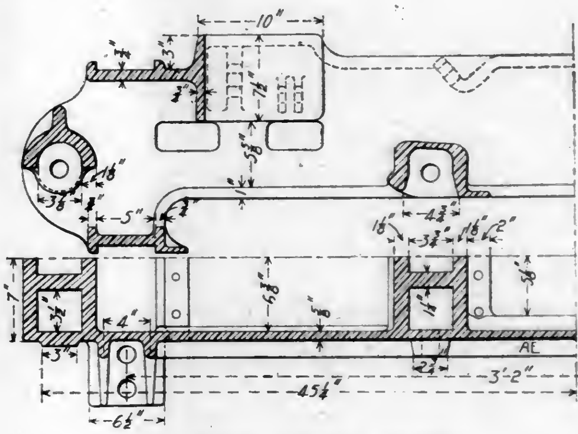
Designed by PULASKI LEEDS, *Superintendent of Machinery.*

CAST-STEEL TENDER TRUCK WITH DIAMOND SIDE FRAMES.

Louisville & Nashville Railroad.

The increasing weight of tenders for passenger locomotives making runs of 100 miles between stops has made it necessary for the Louisville & Nashville Railroad to provide a much stronger tender truck than has been heretofore used on that road, and the design shown by the accompanying illustrations was made and put into service by Mr. Pulaski Leeds, Superintendent of Machinery, about eight months ago. The truck embodies several interesting features, particularly with reference to the spring hanging and the arrangement of the journal brasses.

The fast passenger trains on this road are handled by 20 by 26-inch 10-wheel engines with large tenders, which, with their full capacity of water and coal, weigh 108,000 pounds. The side frames have arch bars 5 by 1½ inches in section, while the pedestal-tie bars are ⅝ by 5 inches. The bolsters are supported by two 31½-inch semi-elliptic springs at each end, making four springs for each truck. The springs are slung in forged hangers, which are provided for in the frame casting, as shown in the sectional views. Under the springs on each side malleable safety castings are bolted, the bottoms of which are perforated to save weight, and these castings are intended to catch the springs in case they break. We are informed by Mr. F. A. Beckert, Mechanical Engineer of the road, that this spring arrangement gives a very easy motion to the tenders. The center plates and side bearings are of the standard pattern used by this road and were provided in the design of the steel bolsters. The center plates have a large bearing surface. The journal boxes are provided with end stops and were designed specially for use under these tenders. The bearing of the journal brass in the top of the journal box is made crowning to a radius of 7¼ inches, the top of the brass being made to fit it. This is in accordance with the practice of Mr. Leeds in applying the load to the journal brass in such a way as to distribute the load uniformly over the entire length of the brass, instead of allowing it to come upon the ends, as is often the case with the ordinary brass and wedge. We are not told the weight of this truck, but judging from the sections of the castings it must be exceedingly strong, the metal being not less than ⅝ inch thick.



Half Section Through Transom.

Before placing these trucks in service the transom and bolster were marked with a prick punch, and the marks were referred to a very rigid three-point tram, which was done for the purpose of detecting any deflection or permanent set. No perceptible deflection was found in any of the parts when the tender was loaded, and none has been detected after eight months of hard service, in which the design has been found to be very satisfactory.

Water tubes through the fireboxes of a number of locomotive boilers on the Southwestern Railway, (England), were illustrated in this journal on page 79 in March, and page 223 in July of last year. "The Engineer" speaks of this experiment in the following glowing terms: "Mr. Drummond, of the Southwestern, has carried out a most successful experiment by putting in water tubes. These tubes, exposed to the full fury of the furnace gas, have been found to give no trouble whatever, while they greatly improve the steam making powers of the boiler."

We desire to call the attention of every reader of this paper to pages XVI. and XVII. of this number. If you do not have a paper, send 20 cents to the publication office and one will be sent to you.

F. W. DEAN ON LOCOMOTIVE PRACTICE.

In a suggestive criticism of locomotive practice before the New England Railroad Club recently, Mr. F. W. Dean brought out a number of points which are of special interest. Mr. Dean's standpoint is that of a Mechanical Engineer experienced in both stationary and locomotive practice. He appreciates the necessity for improving the locomotive in its use of steam and sees the possibility of applying to it in some degree the means of which have brought about the advancement of stationary engines.

Mr. Dean says that the desire of everybody to be through with a railroad journey will always make demands upon railroad companies in advance of their performances. The manifest conditions of passenger service are the desire of the traveling public to move quickly between distant points and to be surrounded with luxury while doing so. Increasing density of population shows a tendency to require more numerous short distance trains, which will probably be the field for the application of electricity to steam railroad service. Mr. Dean believes the use of electricity for main line service to be highly improbable.

He makes a good point when he says that if as much encouragement were given by the railroad companies to the improvement of the economy of steam locomotives as has been given by some of them to the improvement of electrical plants, or in changing smoke stacks and many other trivial things, the locomotive would probably leave the electric traction well behind in economy.

A desire to travel fast and to pull heavy trains leads to the building of larger engines and in a review of foreign practice Mr. Dean brings out the fact, without however commenting upon it, that the form taken in this direction abroad is to greatly extend the use of four cylinder compounds.

Professor Goss remarked upon his return to this country recently that the four cylinder compound was the only type of compound now making progress in Continental Europe. Perhaps Mr. Dean's failure to comment upon this fact is due to his opinion, which is in favor in the two cylinder rather than the four cylinder type.

The discovery that a stroke of 24 inches has no special virtue for the cylinders of locomotives, the use of higher steam pressures and the conspicuous increase of size of locomotives received the author's attention, and in boiler design the abandonment of crown bars is considered an important advance. Many of our readers will agree with him in objecting to the retention of former small grates in spite of the large increase in heating surfaces of recent years. The author of the paper says "There is very little to be gained by increasing heating surfaces unless the grate service is increased also. What is wanted most of all in large locomotives is more grate surface, for this is the heat making part of the boiler. More heat is wanted, and nothing but grate area can give it without difficulty and with economy."

In looking into the future the author warns against an "enlargement of defects" along with the increase of capacity. It is clear that he considers valves and valve motion as constituting a field for improvement with particular reference to the wire drawing of admission and exhaust, both of which operate to reduce speed and power and tend toward the use of cylinders that are too large to be economical. The loss of economy in the large cylinders is due to increased cylinder condensation and the extra work required to overcome back pressure. Mr. Dean does not deprecate efforts to reduce back pressure, but he strongly advocates more attention to the augmentation of the propelling pressure. The increase of propelling pressure has been ignored while the reduction of back pressure has received a great deal of attention with small results.

A fact worthy of careful thought is presented in a reference to the application of four Corliss valves to some locomotives on the Paris & Orleans Railway. It was shown that to these valves alone a saving of from 9.2 to 16.25 per cent. of water was due when compared with a slide valve engine of the same size and carrying the same steam pressure. Another engine in one year saved 15.2 per cent. of coal when compared with the average of 18 slide valve engines. The ordinary engine did 14,343 foot lbs. of work with one lb. of steam and the four valve engine gave 15,727 foot lbs., the steam pressure in both cases being 142 lbs. Mr. Dean makes no comments as to the probable reason for this, but if he did he would probably say that the advantages of the four valve engine lie in the reduction of clearance and in the fact that the steam ports and passages are not used alternately for live and exhaust steam. The time may come when the advantages thus obtained will more than offset the difficulties due to the mechanical complications.

RELATION OF CAPACITIES, GENERATORS AND MOTORS

In Electrically Driven Shops.

The proportion of generator and motor capacities in the electrical power plant of the Baldwin Locomotive Works, as stated on page 49 of our February issue, has attracted considerable attention, and it requires, perhaps, a little more explanation.

The original installation consisted of 700 horse-power of generator capacity to operate a total motor capacity of 2,000 horse-power. This was sufficient at the time because the average load at the switch-board was only 570 horse-power. The capacity has increased to 1,550 horse-power in the generators to operate 3,500 horse-power in the motors. Of this generator capacity one 250 horse-power unit is in reserve, leaving 1,300 horse-power in use. About 400 horse-power of the motor equipment is idle and in repairs, which makes the proportion 1,300 in the generator to 3,100 in the motors.

This motor capacity is the sum of the rated full load capacities of all of the motors, and many of them are of larger size than the average work calls for. This surplus is provided in order to take care of very severe service conditions at times. For example, nine-tenths of the time the machines may be working at finishing cuts while one-tenth of the time they will be doing extremely heavy work, calling for the full capacity of the motors. Mr. George Gibbs says that about one-third of the rated motor capacity will usually be ample for the generative capacity in large plants. In smaller plants, this rule would not always apply, especially when absolutely reliable service is required. In such cases a spare unit in the power-house is needed.

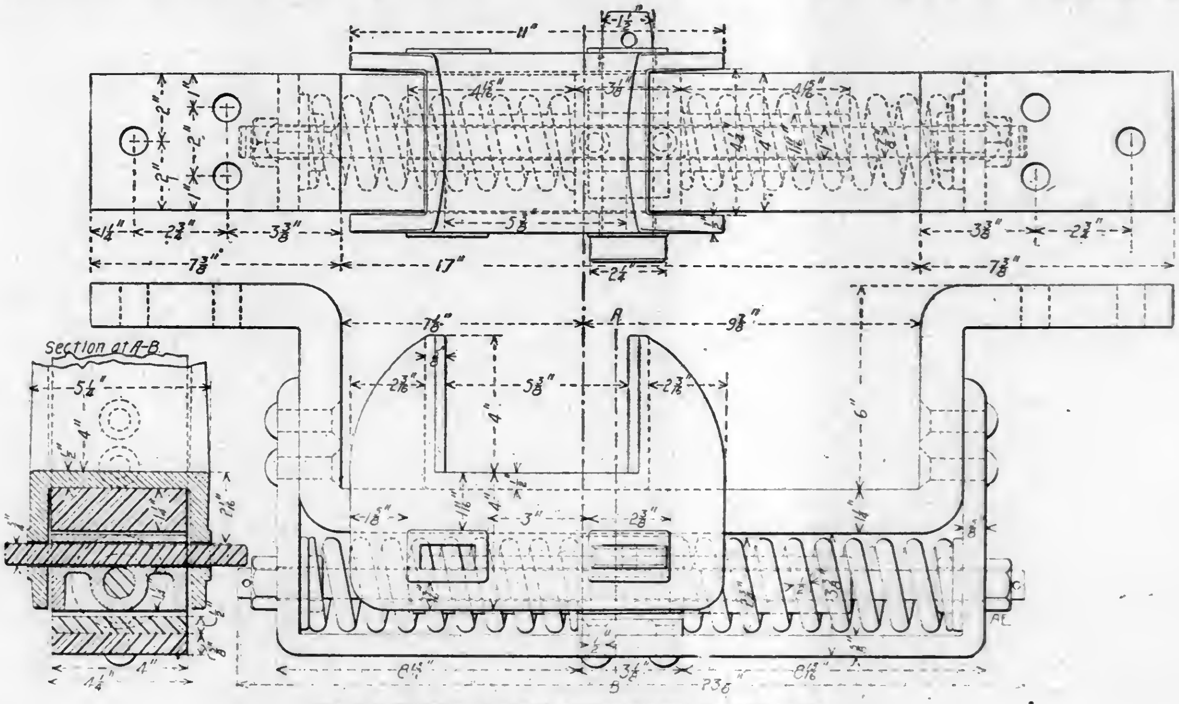
It is interesting to note in this connection the statement made by Mr. Burcham Harding, concerning the Westinghouse motors at the Duquesne works of the Carnegie Steel Company where the intermittent operation of the motors is carried on from the central station by means of one-sixth of the horse-power previously required when separate engines were used.

A draft rigging, which will sustain a load of 163,000 lbs. with a deflection of but 0.204 inch and will hold a load of 132,500 lbs. for 13 days without breaking is a good one. We are informed of a remarkable test of the Dayton Draft Rigging at the test room of the Robert W. Hunt Co. in Chicago, in which an initial load of 40,000 lbs. was increased by steps until it reached 163,000 lbs. with the above mentioned deflection, whereupon a key in the testing machine broke. It was impossible to take the draft rigging out of the machine for 13 days, during which the load fell from 163,000 to 132,500 lbs. Nothing could prove more conclusively that the design of this draft rigging is sound, that the material is good and that it is disposed favorably for transmitting and resisting enormous stresses. The rigidity of the structure and the simplicity of construction are reflected in the very small deflection.

YERK'S SLIDING COUPLER YOKE.

The draw-bar sliding yoke shown in this engraving was designed and patented by Mr. G. Yerk, who is in charge of the platform department of the Pullman Palace Car Company at Pullman. It is being applied to the sleeping cars of that company, and several of the western roads are considering its adoption. The drawing was brought to our attention in the office of the Mechanical Engineer of the Burlington, Mr. F. H. Clark, and it is understood that a modification of the plan is likely to be adopted for all the passenger cars of that road.

The ordinary carry irons provide only about ½ inch play on each side for the relief of the coupler in taking curves. This is not enough, and Mr. Yerk has allowed a total motion of about 5 inches. The coupler shank is held in a malleable-iron yoke resting upon a carry iron 1¼ by 4 inches in section. The yoke has flanges at the front and rear, and by means of a key through these flanges the yoke is secured to a block which is held centrally between two springs of ½-inch steel. The springs are mounted in a stirrup below the main carry iron and they allow the movement of 2½ inches to each side of the normal position of the coupler. The side motion is limited by the lengths of the pieces of pipe through which the rod passes. Two positions of the yoke with reference to the central-spring block are provided, one for the shank of a Miller hook and the other for that of an M. C. B. coupler. The key may be withdrawn, the yoke moved over, and the key placed in the other slot, when it is desired to change the coupler.



Yerk's Sliding Yoke for Passenger Car Couplers.

The idea of this device is not new. It has been used on cars and on tenders, but its advantages are probably not fully appreciated. When the extent of the stresses due to lack of lateral play in couplers is understood, such devices will come into general use because of the relief from racking stresses which they give. The worst condition arises in connection with a car with a long overhang when coupled to a tender. On a sharp curve the car may derail the tender. Such accidents have occurred, and on the Chicago & Northwestern, several years ago, a test was made showing that the stresses imposed upon the framing are enormous. A number of lead blocks were made, and carry irons for a tender were put in with such a width of opening as to take in one of these lead blocks on each side of the coupler shank and give the coupler the usual amount of side motion. The tender was then coupled to a dining car with an overhand of 11 feet, and was pulled around curves of 20 degrees. The blocks of lead were compressed by the side thrust of the coupler, and in order to measure the amount of the pressure other blocks of the same original size as the first were compressed in a testing machine to the exact thickness of the ones which had been squeezed by the couplers. The pressure required to do this was 57,600 pounds, which is approximately a reproduction of the conditions of service. This is clearly an important subject.

We are indebted to Mr. H. M. Pflager, Mechanical Superintendent of the Pullman Company, for the drawing.

NEW GERMAN STEAMSHIP "DEUTSCHLAND."

The "Deutschland," launched January 10, for the Hamburg-American Line, at the Vulcan Yards, Stettin, is expected to be a record breaker. She will cost $3,332,000 and is to enter service between New York and Hamburg during the coming summer. She is being built under the rules of the German Navy, with protected rudder and steering gear, and will be used in naval service if required in time of war. Steam will be supplied from 12 double and 4 single boilers, with 112 fires, which drive two six-cylinder quadruple-expansion twin-screw engines of 33,000 horse power. The two propeller shafts are each 131.23 feet long and 24.8 inches in diameter; each of the bronze propellers being 22.96 feet in diameter. The ship has a double bottom extending its entire length, which is divided into 24 compartments; 15 exceptionally strong bulkheads extending from keel to main deck, and one longitudinal bulkhead in the engine room, divide the steamer into 17 watertight compartments. It is claimed that if two adjoining compartments were to fill with water the ship would not sink. The "Deutschland" is expected to have accommodations for 1,057 passengers and a crew of 525. There are 263 first-class cabins, 99 second-class cabins, and accommodations for 290 steerage passengers. The first-cabin dining saloon is located amidship on main deck, and has a seating capacity of 362. The following table giving the dimensions of the largest steamers is interesting for comparisons of the dimensions of the new ship with others:

Name of Ship.	Date.	Length over all. Feet.	Beam. Feet.	Depth. Feet.	Draft. Feet.	Displacement. Tons.	Speed. Knots.
Great Eastern	1858	692	*83	57½	25½	27,000	14.5
Paris	1888	560	63	42	26½	15,000	20.5
Campania	1893	625	65	41½	28	19,000	21.8
Kaiser Wilhelm der Grosse	1897	649	66	43	29	20,000	22.6
Oceanic	1899	704	68	49	32½	28,500	20
Deutschland	1900	684	67	44	†30	23,200	†23

*Over paddle box. †Estimated.

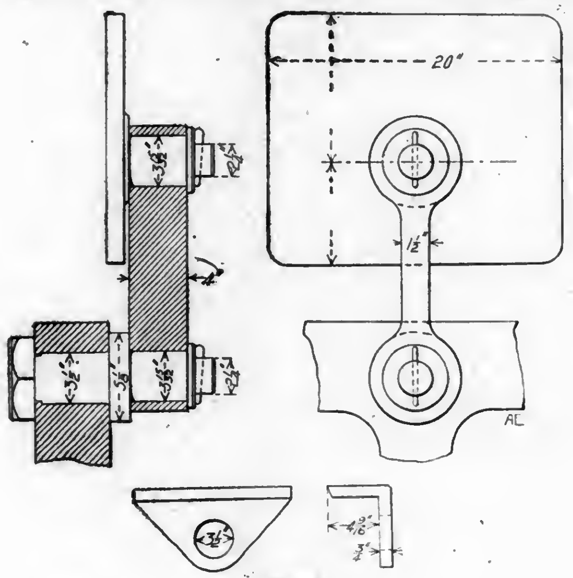


Fig. 1.

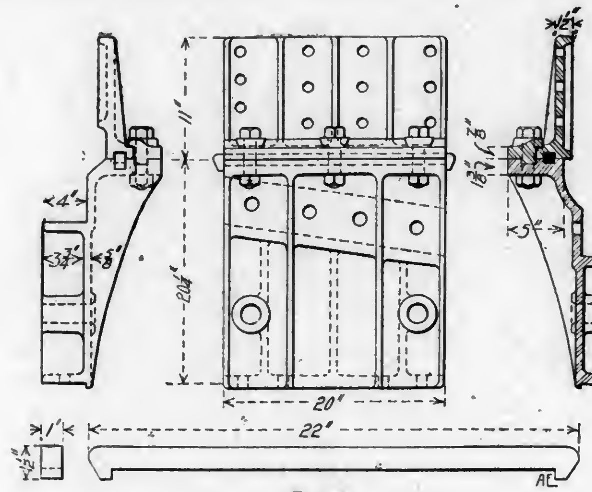


Fig. 5.

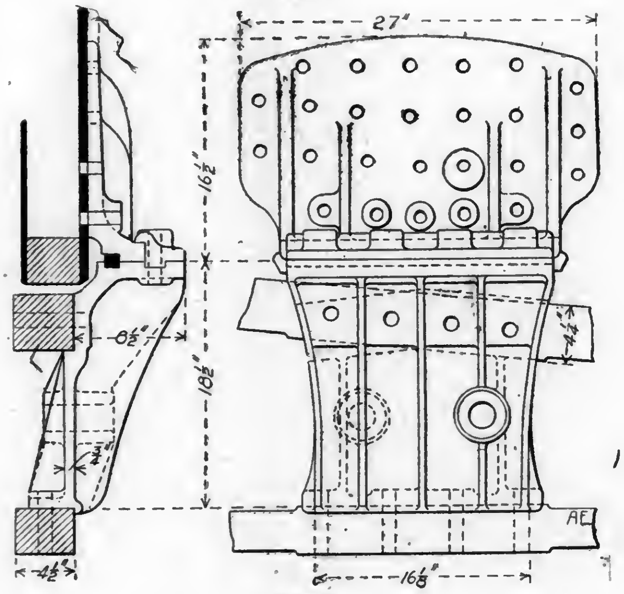


Fig. 6.

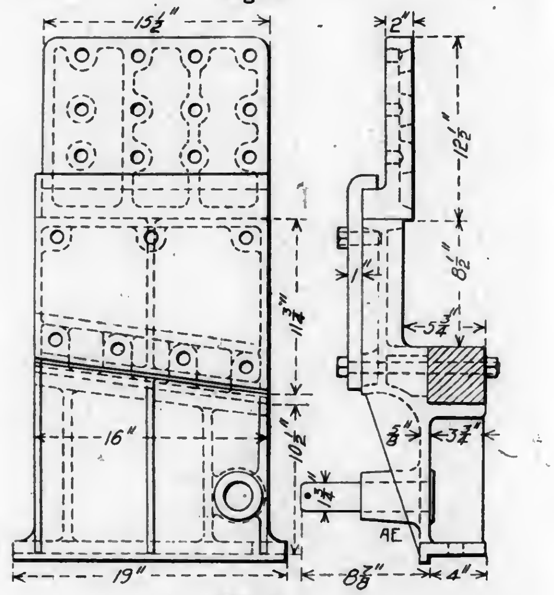


Fig. 7.

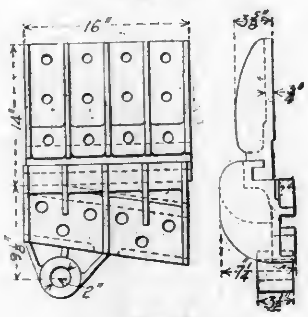


Fig. 8.

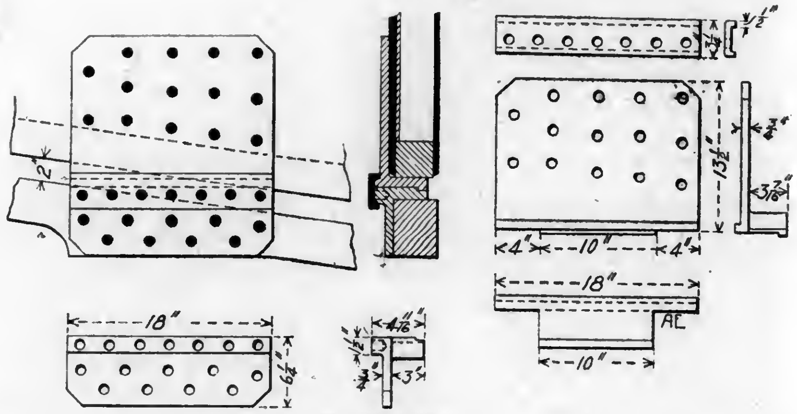


Fig. 9.

SUPPORTING REAR ENDS OF LOCOMOTIVE BOILERS.

When 52-inch boilers, carrying 140 pounds steam pressure and weighing 21,000 pounds, were common, it was not difficult to support them with satisfactory and easily maintained devices, but with the advent of boilers weighing 60,000 to 70,000 pounds, the problem is more troublesome.

Requirements.

The support at the front end being rigid that at the back end must provide for the expansion and the devices used must be light and inexpensive to maintain. They must distribute the load in such a way as to reduce to the minimum the vertical stresses in the frames, and they must provide for wear to be received upon parts which may be easily renewed and they should not only support the boiler, but hold it against surging stresses and provide for tensile stresses due to handling the engine in a wreck.

The best opinion seems to favor support from the mud ring and doing this with a view of keeping all attachments as close to the firebox as possible, making provisions for distributing the stresses over large areas. It is impossible to lay down rules for this detail because of the variety of conditions met in the design of locomotives of different types and for different purposes.

Support by Links.

The link method which has held a prominent place for a number of years, is not now generally favored because of the difficulties in maintenance. This is the lightest arrangement

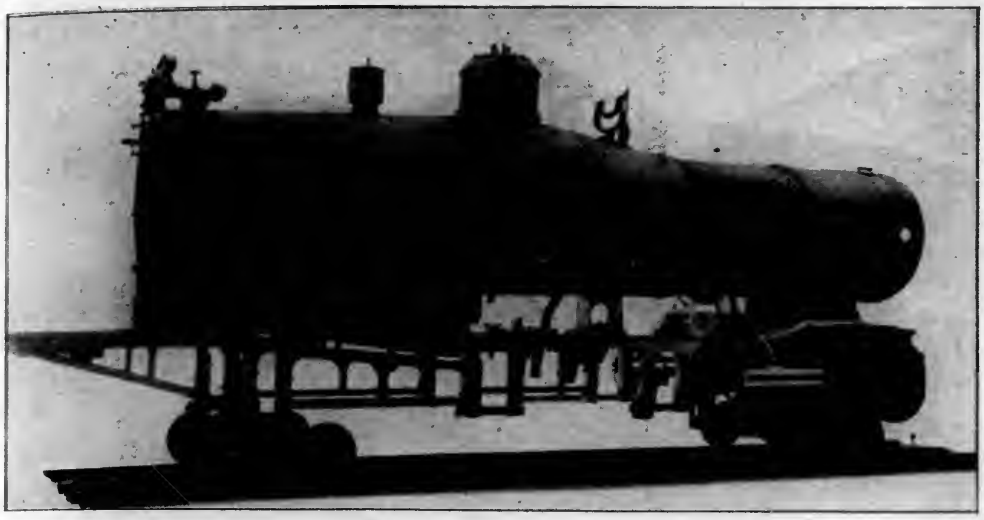


Fig. 1A.

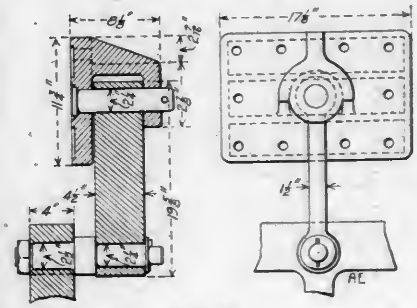


Fig. 2.

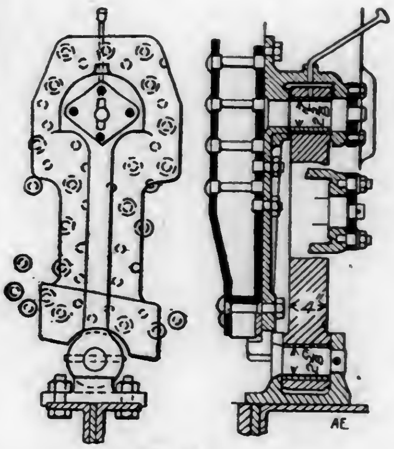


Fig. 3.

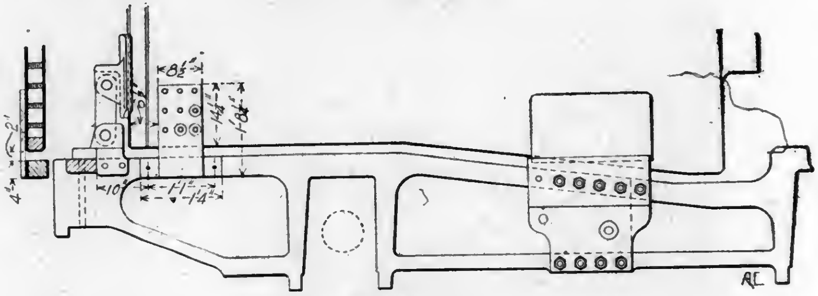


Fig. 4.

used and it has an advantage in being equally effective in tension and compression, and in a wreck or derailment this feature is valuable. The link has fallen into disrepute in some cases because of faulty design, but even when well designed and with very strong pins the bearing surfaces to receive the wear are not as large as may be desired. The pins must be long if the links are wide, and this sets up severe bending stresses in the sheets on account of the overhang or leverage.

Several designs are shown. The Schenectady Locomotive Works' link plan is shown in Fig. 1, and Fig. 1 A, the Richmond Locomotive Works in Fig. 2, and a design elaborate in detail, for the Austrian State Railways, in Fig. 3. The method of supporting the boiler direct to the equalizer by means of a strut between the bars of the frames is shown in the Schenectady design. The Austrian links have hardened pins and bushings and are provided with oil cups. This design may be criticised with many others because it is necessary to jack up the boiler in order to take the supporting devices down. The pads for the support of the upper pins are very large and even take in the mud ring. The oiling device for the Austrian links is a good idea which ought to be used on other arrangements such as pads.

The link arrangement used on the moguls of the C., B. & Q. is shown in Fig. 4. This has worked very well for a number of years. The links in this case are 2 by 4-inch rectangular bars with steel bushings, and the brackets are secured to the back of the firebox and to the ends of the frames. The side thrust is taken by plates secured to the firebox.

There are many advocates of the link method, and the fact remains that in spite of theoretical disadvantages it has done very well in some cases. There is a tendency to distort the sheets to which the pads are applied, which appears to be a serious objection. This is improved by the use of large pads. Many roads have abandoned the link in favor of other methods, while others have a large number of heavy engines supported in this way.

Pads Resting on Brackets.

The use of cast-steel brackets is quite generally favored. These are made in a variety of forms. The principles are about the same in all and the details vary according to circumstances. Those illustrated embody a support between the bars of the frame with supporting surfaces for the boiler, in which lateral and lifting stresses are provided for. In Fig. 5 the plan used in Schenectady engines for the New York, New Haven & Hartford is shown. Mr. Henney kindly furnished the drawing and stated that this arrangement has been satisfactory, giving no trouble whatever. The bearing between the upper and lower pads consists of a tongue and groove with a steel key to take the side thrust.

The large pads and brackets used in the new Brooks 10-wheel passenger engines for the Lake Shore (November issue, 1899, page 344) are shown in Fig. 6. These give good support and seems to work well in every way. They are, however, very heavy. The 10-wheel passenger engines built by the Richmond Works for the Southern Railway (our issue of March, 1898, page 83) have pads and brackets of the form shown in Fig. 7, by courtesy of Mr. W. H. Thomas. This plan gives a generous bearing for wear and large 1-inch plates lipped over the boiler pads take the lateral and lifting stresses. This is a strong design, but is not light in weight. Fig. 8 illustrates another form in cast steel which has been used by the Richmond Locomotive Works. It does not have the advantage of easily separating the boiler from the frames. The pads must be taken off in this case. This drawing represents a large class of boiler bearers made by several builders, but they are not the most convenient kind.

Mud Ring Support.

Two ways of supporting boilers by the mud rings are shown in Figs. 9 and 10. Fig. 9 is a design by the Richmond Locomotive Works as used with sloping frames. This plan has the advantage of removing the stresses due to the weight of the boiler from the pad studs to the mud ring, where they are received nearly centrally upon the frames without causing twisting moments. The design becomes simpler for level frames. This plan is simple, neat and strong. It places the stresses where they may be best provided for and the space

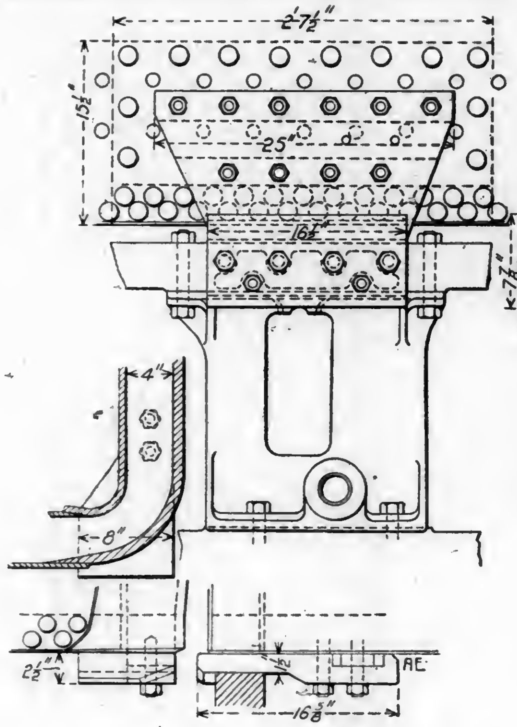


Fig. 10.

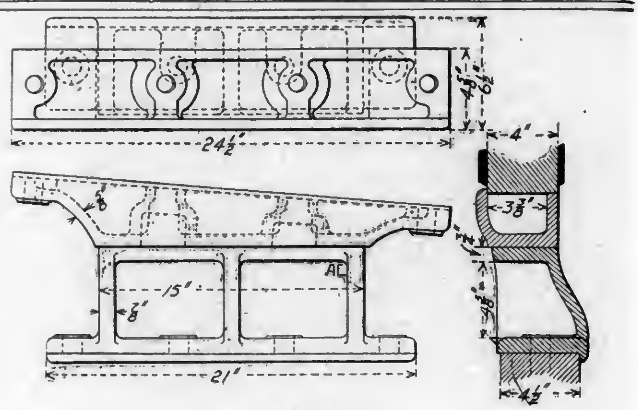


Fig. 11.

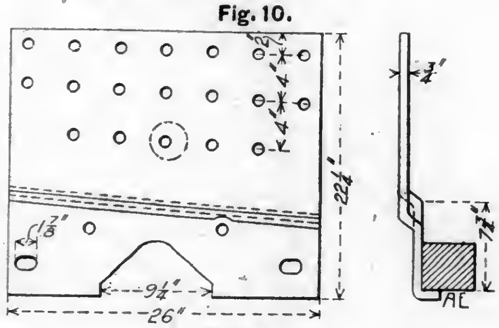


Fig. 12.

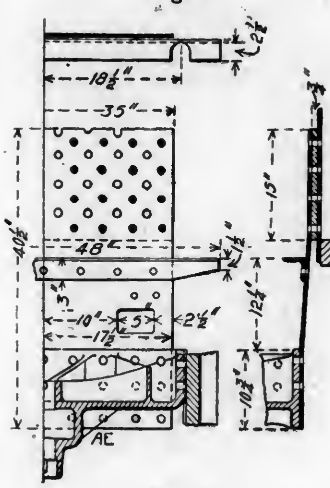


Fig. 13.

taken up is not required for other parts. This construction, being of wrought iron, is expensive, but we can not see any objection to it. The additional cost is believed to be amply compensated in the long life of the parts and relief of the firebox sheets from injury. The lip and shoulder in the bearing portions under the mud ring should not be overlooked.

A somewhat similar design is used on the heavy freight locomotives on the Pennsylvania, classes H5 and H6, as shown in Fig. 10, which is reproduced from the description of these engines in this journal (issue of June, 1899, page 181). In this case steel castings are fitted between the bars of the frames, terminating at the top in a long block, the top surface of which is flush with the top of the frame. Pads, secured to the boiler by studs, and provided with broad bearing flanges, receive the weight of the boiler and transmit it to the lower bearing surfaces, which are protected from wear by thin steel shims which are easily renewed. A ⅜-inch reinforcing plate is placed against the firebox sheet, inside the water leg, into which the studs are screwed.

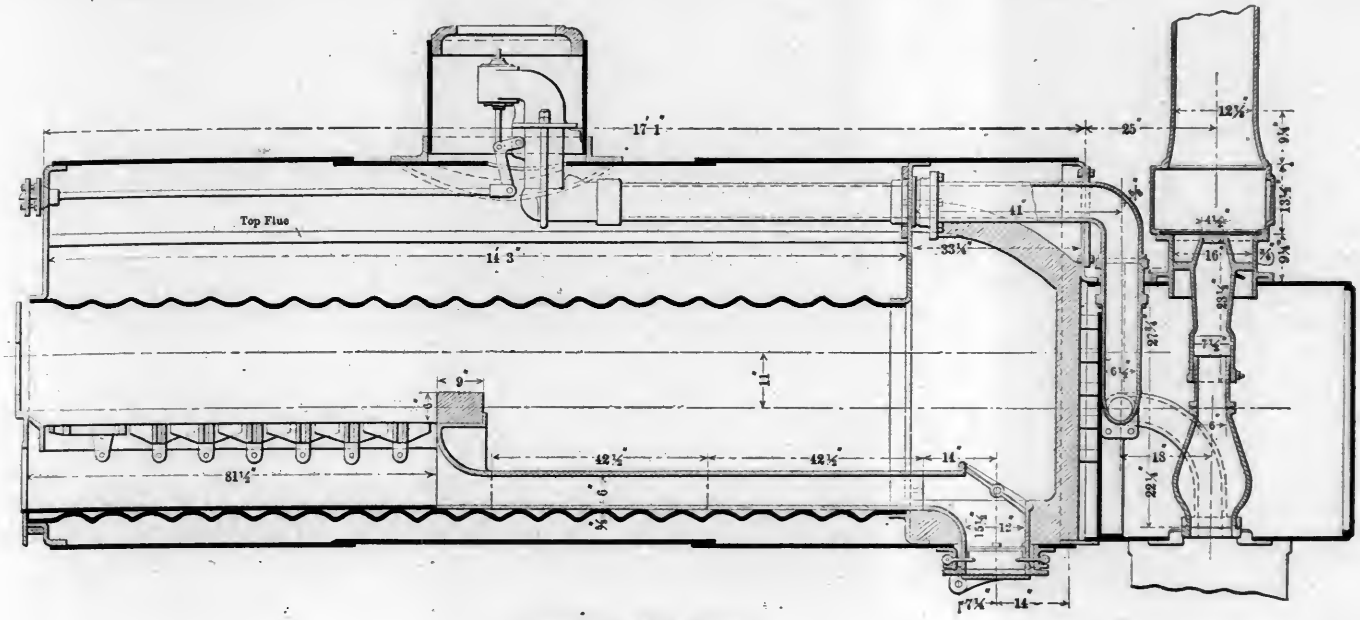
This design has the important advantage of removing all tearing stresses from the studs in the pad. The firebox tends to push against the studs. This plan seems to meet all the requirements admirably and no fault has yet been found with it. It is the standard practice of the Pennsylvania.

The method of supporting by the mud ring shown in Figs. 11, 12 and 13 was used on the new Brooks consolidation engines for the Lake Shore & Michigan Southern illustrated in our February number. Fig. 11 shows one of the pairs of shoes placed under the mud ring. There are two pairs of these on each side of the engine. Those in front are very shallow, because they are fitted between the mud ring and the top bar of the frame where the space is not as great as shown in Fig. 11. These shoes are of cast steel and very light. They give no support against lateral or rolling stresses and they do not assist in lifting the frames by the boiler in wrecking operations. These features are provided chiefly by the large ½-inch plate of Fig. 13, which is secured to the back boiler head and to the front face of the cast steel foot plate. The boiler studs are ⅞ inch in diameter and it will be noticed that the plate is drilled opposite each staybolt. This plate may assist in carrying the weight, but it is not expected to do so. It distributes the transverse stresses over a large area on the back head and it seems to be an excellent plan. Plates have been used in this way for a long time on wide firebox engines. A ¾-in. plate, Fig. 12, is used to assist in furnishing attachment between the boiler and frames in a vertical direction. This plate covers the shallow mud ring shoes similar to Fig. 11. It also furnishes some lateral resistance. The chief object of this plan was to support the boiler safely with the minimum amount of added weight.

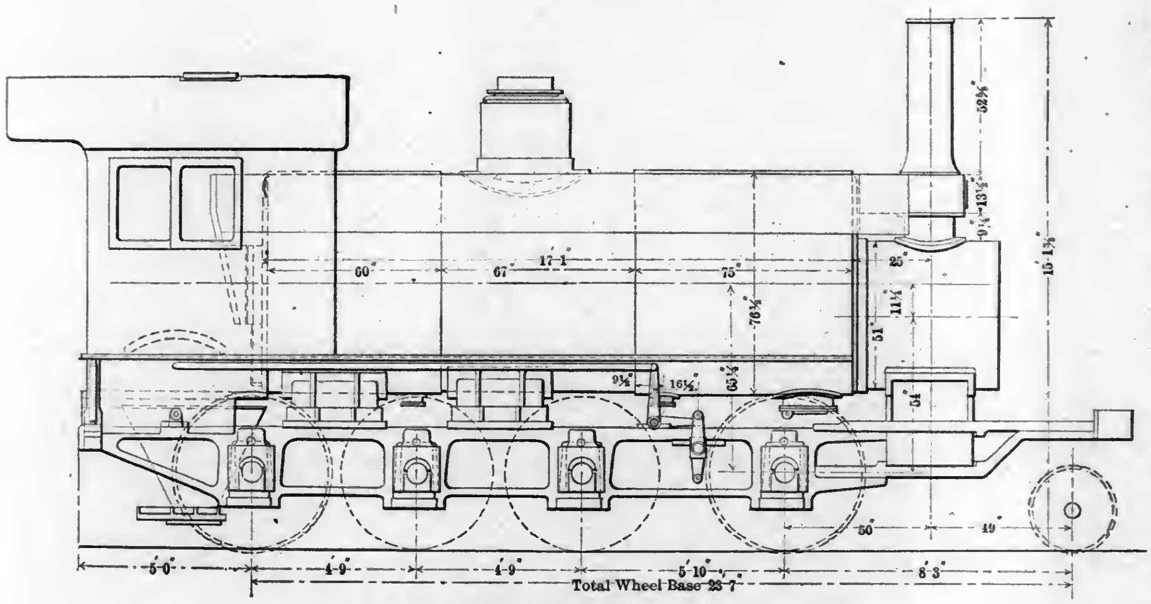
The necessity for lubricating boiler supports of whatever kind is not properly appreciated. Oil cups should be provided for links, brackets or mud ring supports. In link suspension it is not uncommon to find the surfaces rusted so tight as to defy release, except by removing the plates from the firebox. The resistance to motion in these parts when thus fastened together must necessarily throw undue stresses on other parts, and it is possible that some cases of broken cylinders and saddles may be explained in this way. The new Schenectady engines for the New York Central have oil cups to lubricate the boiler bearers. All of these devices ought to have facilities for oiling.

In using pads for vertical as well as lateral support, care should be taken to get them large enough to get in a sufficient number of studs.

The foregoing discussion may be summed up as follows: The best plan, wherever it can be used, is to support the boiler by the mud ring, or by the mud ring and by lateral plate braces. Next in order of excellence is the pad and bracket with area enough to give a large number of studs, while the link suspension seems to lack the best features of the bracket and mud ring plans.



Longitudinal Section.



Experimental Marine Type Boiler for a Locomotive.
Atchison, Topeka & Santa Fe Ry.

A CORRUGATED FIREBOX, RETURN-TUBE LOCOMOTIVE BOILER.

Atchison, Topeka & Santa Fe Railway.

A novel experimental locomotive has just been completed at the Topeka shops of the Atchison, Topeka & Santa Fe Railway from drawings prepared under the direction of Mr. John Player, Superintendent of Motive Power of that road. The grates, which are of the rocking type, are placed in the rear end of a 40-inch corrugated, marine furnace flue, 14 feet 3 inches long, which opens at the front end into a "back connection," and the products of combustion pass backward through about 130 tubes to a cross connection at the cab end and thence pass forward through a plate duct along the boiler to a very small smokebox or chamber, into which the exhaust nozzle opens, to throw the blast up the stack. Air is admitted at the back end under the grates and also from a duct which opens under the bridge wall and brings air from under the boiler, just in the rear of the cylinder saddle. A butterfly valve may be opened between the front end of this duct and the "back connection" if air is needed at that point for perfect combustion. The ashes are raked out of the furnace at the back end, where they are received in a hopper which is slung under the deck of the cab. The bottom of the furnace is protected from the ashes, and the front of the combustion chamber from the heat of the flames. The arrangement of the steam and exhaust pipes and an idea of the exterior appearance of the engine are shown in the engravings. The idea of using a corrugated furnace in a locomotive in such a way as to secure a large amount of combustion space is new. This boiler is understood to be entirely experimental, but there seems to be no reason why it should not be successful. If it accomplishes nothing more than to do away with staybolts it will serve a most useful purpose. Attempts to improve the locomotive boiler are so rare that experiments of this kind ought to receive the heartiest encouragement. Locomotive men are so conservative about unusual designs that it requires a great deal of courage to bring out anything of this sort.

The attention of every reader of this paper is directed to pages XVI. and XVII. of this number. A copy of the paper will be sent to your address if you will send 20 cents to our publication office.

Recently, on the London & North Western, the Irish mail encountered a bale of cloth which threw several coaches over upon the freight track to be run into by a freight train. This seems like boy's play rather than real railroading.

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Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

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Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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It is surprising and gratifying to see the results of our efforts to bring out the bright and experienced young men in the motive power departments and place them in communication with officers who are in need of their services. A statement of unsolicited response is printed on page XVII. of this issue.

A real reform is needed in the matter of salaries paid by American railroads to their motive power officers. In England the locomotive superintendent is paid a salary nearly as high as that of the general manager, and he is considered as one of the most important officials, although his duties cover no more, and generally not as much, ground as is the case in this country. No department of a railroad offers such opportunities for administrative wisdom to produce real economy as that in charge of locomotives and cars. No private employer would think of expecting a superintendent of motive power, for a salary of $3,000 to $5,000, to honestly and wisely administer expenditures amounting to several million dollars per annum. This is often done in railroad service. It is a difficulty which must correct itself in time. Those managements which recognize the importance of this question and make it clear that mechanical ability is appreciated are wise.

More than one successful man owes his beginning in advancement to the special study of some one subject and to the fact that others are aware of his proficiency in it. In some cases this has resulted from a paper before a technical association or good work done in connection with a committee report or as a part of an engineering investigation. Such a course is advantageous also because the very process of preparing one's information to be made available for others involves the crystallization of ideas, and a man always understands himself better because of trying to place his information in form for record. The technical associations offer means for advancement which ought to be more generally appreciated. Recently two papers which are worthy of remark were discussed before one of the railroad clubs. They were presented by men whose class is not often heard from in this way. One, on piece-work, was written by a shop machinist, and the other, on pooling locomotives, by an engineer of a freight locomotive. The papers are excellent, and that on pooling is the best so far produced on the subject. It is safe to say that these men possess qualifications which will lead to greater responsibilities. They have set an example which should be suggestive to many others who occupy much higher positions. Several able men who now occupy high positions while comparatively young have profited by this idea. Those we have in mind have a high professional principle in mind in this connection. They believe that when a man has secured professional information by study and experience he ought to give the benefit to others because he desires to learn from others. This is a strong and unselfish reason for what we advocate.

ARRANGEMENTS OF TRACKS IN ERECTING SHOPS.

The question of the track arrangement in shops, whether longitudinal or lateral, is one of the first which is considered in drawing up plans for new shops or in making improvements in old ones. There are differences of opinion, and some time ago we gave considerable space to this subject, rather favoring the longitudinal plan as a result of an examination of the shops of the Boston & Maine at Concord, N. H. Having been taken to task recently for this position by a Superintendent of Motive Power who has just completed plans for new shops, and being met with several good arguments, it seems advisable to present them. They come from one who has used both systems, and he strongly advocates the lateral plan from his experience.

The question of cranes versus transfer tables is the first to come up. He directs attention to the fact that a great deal of lifting of locomotives as a whole is required with the longitudinal tracks. This requires a heavy crane at each end of the engine, whereas a single heavy crane is required for the other plan. A second and lighter one, or two lighter ones, may be used for the cross-track shop if desired. It is also argued that a transfer table costs less than the second heavy crane.

One of the arguments against the long tracks is that the high lift required to carry locomotives over others standing on the same track necessitates a much higher, and consequently more expensive shop, because in this case the lift must be at least 20 feet, whereas in the other case the lift need be only sufficient to take the driving wheels out from under the engines, or from 6 to 8 feet. The same total length of track will accommodate the same number of engines in either case, but it is stated that the shop is much more cluttered up with the parts of engines in the long track plan, and an additional objection is that the pits of the long tracks must be covered with boards

when not in use, and even then the pits make it difficult to carry heavy parts about. These ideas may or may not be new to our readers, but the argument seems to be a good one. The cross-track system has the practical endorsement of the locomotive builders.

WHAT MOTIVE POWER OFFICERS ARE THINKING ABOUT.

Recent conversations with eight representative motive power officers, at their headquarters, indicate, by the voluntary introduction of the subjects, that the following are the most important lines for development in the immediate future:

Compounds.

The compound locomotive has gained ground remarkably during the past year. It has now become so well established upon one road where careful comparisons have been made for four years, that it is believed to be safe to say that nearly all future road engines for freight and passenger service there will be compounds. The records made by simple and compound locomotives, in the same service, on this road, show a saving by the compounds of 18 per cent. in fuel and between 5 and 6 per cent. in repairs in four years. On another road which heretofore has been satisfied to allow others to do the experimenting, a good-sized investment in compounds has been decided upon in confidence of securing advantage not only in fuel economy but also in repairs and in mileage. Carefully kept tonnage rating statistics have contributed to this result. With this turning toward the compound there is a noticeable tendency toward a proper consideration of satisfactory operation in the design of compounds. The provision of ample power when running in compound working is the most important factor to be kept in mind in ordering engines of this type.

Heavy Locomotives.

The heavy locomotive for both passenger and freight has a strong hold and the heavy engine is not at all a fad, but a recognized improvement in operation. Engineering departments are more liberal in the limitation of driving-wheel weights and managers are more appreciative of the necessity of favoring the locomotives by bringing the bridges up to the requirements. A general breaking down of the individual department idea is progressing. The engineering departments are less bitter in their denunciation of heavy engines because it is clear that they are needed.

Wider Fireboxes.

The coal situation throughout the west is such as to emphasize the importance of providing in the design of fireboxes for a much wider variation in the quality of fuel than has been considered necessary. Several of the important trunk lines have been seriously handicapped by the necessity of using coal that a short time ago was rejected. In one case 75 cars of coal actually refused and returned, four months ago, have since been cheerfully received and used for want of better fuel. This makes larger grates appear attractive not only because they offer greater leeway to meet the accidental state of the coal market, but also because they make it possible to use lower grades of coal. The extremely large grates required for anthracite coal are not needed with most western coals, but a moderate increase of area, obtained by increasing the width of the firebox, may be expected on several roads in the near future.

The Fireman.

The demands upon heavy passenger locomotives in use on a number of roads involve an amount of work for the firemen which is nearer the limit of their physical endurance than is generally realized. When all goes well a heavy passenger run is not so hard, but in zero weather, in snow storms with everything frozen that can freeze, with from 60 to 100 lbs. steam pressure for heating a train of from 10 to 14 heavy cars, the firing of the engine is a hardship. A regular run of 180 miles requires, say, 8 tons of coal in 4½ hours, with 8 cars. This is comparatively easy on the fireman in good weather, but when the train has an extra car, when the weather is bad and one-half hour is to be made up, ten tons of coal are handled by the fireman in 4 hours, or 2½ tons per hour. Three tons per hour is satisfactory work by a laborer in the coal chutes, where it is merely moved by the shovel, but the fireman must not only handle nearly as much as this, but he must place it skilfully on the grates, keep an eye on the steam gage, help the engineer with the water, and, what is worse, he must average several steps after each scoopful of coal. Men do this right along every day and little is thought of it. A question of two firemen on a locomotive may be up for settlement some day. That time will be deferred by aiding the fireman as much as possible. When there is an opportunity to do so, it is worth while to have a laborer shovel the coal forward at some water station stop to save steps for the fireman during the latter part of the run. The sloping tank is good, but it does not go far enough, and with coal containing much slack the shoveling is necessary, because it will not run of itself. The best way to relieve the fireman, which means also relieving the engine, the track and all, is to reduce the lost time to the lowest possible amount. Better attention to the signaling and the modernizing of water stations are labor savers which are not appreciated. When these are as they ought to be, there will be no slackening of speed on account of uncertainty about signals, and water station stops will be reduced to seventy-five seconds. Both of these items become very important in fast runs and especially when making up time.

This is a subject which is spoken of rather guardedly. It is, however, a most important factor, and will soon compel the consideration of improvements in the use of steam with a force that is not to be ignored. The tendency toward increasing the demands for steam was seen recently in a new way. It was on an engine hauling 14 cars in a passenger train. In order to heat the cars a special order was issued by the Division Superintendent to the engineer instructing him to carry a steam pressure of 80 pounds per square inch on the train heating system. The combination of severe requirements for passenger service, particularly in winter weather, is a matter fit to worry about, particularly because the end is not yet in sight.

Piston Valves.

Piston valves make friends everywhere and we shall soon hear of roads which will order no other valves. The opinion that this is one of the greatest improvements in modern locomotive designing is justified by the views of those who are best able to see its merits. The satisfaction with the principles of the piston valve appears to be universal where it is used, and the fact that it is being adopted in switch engines shows its present status. Central admission and hollow valves seem to call out the best and strongest endorsement. It is believed that this type of valve will soon be made to show greater improvements than have thus far been brought out. Experiments are now being made on an important fundamental and promising improvement in locomotive valve motion. In a short time it will be shown that locomotive cylinder clearances can be reduced to terms heretofore believed to be impossible of achievement. We shall seen see designs for applying piston valves to old engines to replace the flat valves upon the tops of ordinary cylinders.

Engine Failures.

Systematic watching of the failures of detail parts is practiced on a number of leading roads, and in consequence there is a remarkable reduction in the number of failures in service which formerly caused delays to trains. This is not a new idea but it is coming into more general use. There is no better way to study design than to observe the effects of improvements in the form of slight changes in the shape and size of parts. In crank pins, axles, piston rods and parts of valve gear and spring rigging, the effect is most marked. One of the best ways to keep these records is by aid of printed sheets

bearing, in copying ink, outline sketches of the various parts, upon which local officials may indicate the location of fractures; and on the same sheet space for explanatory remarks is provided. These, when collected for a definite period, furnish a great deal of positive information as a basis for changes in design, and subsequent records bring out the effects of those changes. This involves very little time and labor, and the returns amply justify the trouble. In fact this is the only way to secure this important information.

Car Construction.

In car construction the greatest amount of thought is being put upon methods for increasing capacity without unduly increasing weight. The high prices of steel account for a tendency toward the development of large capacities in wooden cars with deep trusses and metal bolsters. Next in importance is the improvement in draft gear. For freight cars strong and simple rigging is sought. This applies specially to those roads having recently put very large locomotives into service, some of which give a draw-bar pull of between 45,000 and 50,000 pounds, which is far beyond the capacities of the ordinary draft rigging. The result is that the front portion of trains hauled by these engines are running with the draft springs compressed solid. This is severe on the entire underframing of the car as well as upon the draft rigging itself. In passenger equipment more attention is being given to the lateral play of couplers. Several roads are considering the adoption of spring devices providing about 5 inches of total side play of the coupler shanks instead of 1 inch, which is the prevailing amount. This is a great improvement, particularly in cars having long overhang from the truck centers to the platforms.

Cost of Work.

The most elusive and, at the same time, most valuable information to the motive power officer, is the cost of doing work. It is very easy to omit important items in securing statistics of this kind, particularly in repair work, but in order to effect improvements intelligently such information is necessary, and it is apparent that clerical expenses are being increased with this fact in view. This tendency is reflected in many plans for new shops in which better methods of handling material and economies in the distribution of power are promised. It is not in the actual saving of power that the great advantage of this idea lies so much as in the saving of labor in running the shops and in the transportation of material. Some of the shops which are now being overhauled or supplanted by new ones now employ nine and even more independent steam plants, with the corresponding number of attendants. The centralization of the power plant into a single power station is the rule, and in several of these steam, electric, hydraulic and pneumatic machinery is so grouped as to permit of the minimum cost for attendance. In such a complex plant as a modern railroad repair shop it is necessary to provide all of these power distributing systems, and once having the facilities, each system may be called upon for the service to which it is best adapted.

Men.

Almost universal is the demand for men to take the responsibilities which the present unusual conditions of activity have created. There is a crying need for more systematic methods of training young men for advancement. The great number of changes made during the past year in the motive power departments of many large roads is impressive. It points forcibly to a serious weakness. Giving due weight to the occasional advantages of "new blood," these wholesale changes ought not to be necessary. Theoretically, every man should consider it a most important part of his work to educate and prepare his own successor. Subordinates should be selected with a view of the possibilities of advancement, and the most successful men of the future will be those who apply this broad and fundamental principle. It is easy to find roads in which the entire personnel of important departments are disheartened and discouraged by an utter disregard of this idea. An extreme case of this kind now exists in which seven men are wanted at once in the motive power department of one road. The necessity for this situation is doubted, and the attention of the presidents should be given to this question. It is one which is of vital importance to the stockholders.

The new President of one of our most important roads recently told the writer of his experiences on assuming charge of the property. After he had looked over the situation he met the heads of departments and division officers and told them what he expected them to accomplish in the first year. Some said it could not be done. The reply was: "My expectations are reasonable and you will be given every opportunity to carry them out. If you cannot secure the results others will be invited to try it, but I want you to do it." Very few changes have been necessary, and in three months several of the division superintendents had done that for which the President had allowed a year. This is far better than a "new blood" policy from the start. It has had an almost electrical effect on this road.

There is a strong tendency among railroad officers to follow details too closely. It is necessary to spend more time in perfecting such an organization as will place the responsibilities for detail upon subordinates.

What a difference it would make in great corporations if the heads of departments could get their work running so that they could sit down for 15 minutes every day and think!

CHICAGO & NORTHWESTERN SHOPS AT CHICAGO.

Extensive Improvements.

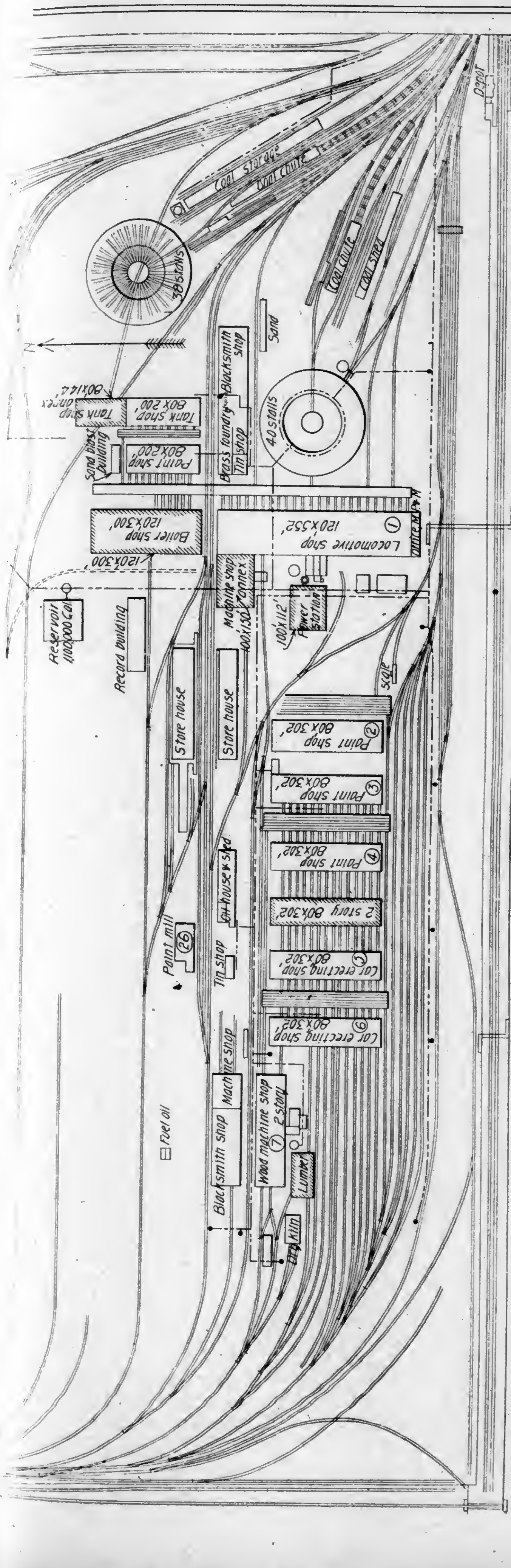
I.

General Scheme.

When the Chicago shops of this road were built in 1872 they represented the best practice of the time. They have not been kept up to date and increased demands necessitated the extensive additions and improvements which are now being carried out to meet the demands of that part of the road which is tributary to Chicago. The greatest need was in the boiler work and it was found that no part of the old boiler department could be utilized. This led to the consideration of these plans.

These shops are the only ones of any extent on the Galena and Wisconsin divisions, where the heaviest work of the road is done. The general repairs for these divisions and the heavy boiler work for the entire road and nearly all the new tank work is done here as well as nearly all of the making of new parts for locomotives and cars. As boiler making machinery is very expensive, it was considered advisable to concentrate all of this work here for 1,062 C. & N. W. engines, as well as that for general repairs of about 500 engines. When the firebox repairs of the Fremont, Elkhorn & Missouri Valley are included, boiler shop facilities for 1,185 locomotives were required, and this is provided in these plans. The complete scheme provided for other extensive additions, which, however, will not now be carried out. The car department will have two new buildings. The plan shown in the accompanying engraving gives the locations of the new buildings, of which there are three for the machinery department, besides an addition to the tank shop. A new power station, a new boiler shop, an annex to the machine shop, and an addition to the tank shop of 144 feet are now under way. The description in detail will be presented later.

The new boiler shop is placed north of the locomotive machine shop and has a floor 120 by 300 feet, with the main portion 67 feet wide. The riveting tower at the north end is 56 feet high and the wing is 67 feet wide by 20 feet high. The old boiler shop becomes the paint shop under the new plan. It is 80 feet wide and will be rearranged inside. At its upper end is an annex for the sand-blast apparatus used to clean old



Extensive Shop Improvements, Chicago & Northwestern Railway, at Chicago.

ROBERT QUAYLE, *Superintendent of Motive Power.* G. R. HENDERSON, *Assistant Superintendent of Motive Power.*

paint from tender tanks. The tank shop is extended northward and these buildings are arranged to be served by an extension of the present transfer table at the east side of the machine and boiler shops. This transfer table pit will be about 900 feet long.

At the northwest end of the locomotive shop is the machine shop annex, in which all of the work of making parts of locomotives will be concentrated. This includes crank pins, piston rods, brass work and other details which are now scattered all over the large machine shop in such a way as to seriously interfere with the other work in the shop. This building is two stories high and it provides for a considerable extension of facilities beyond the present needs. It is 100 by 150 feet on the ground, the first story has 18 feet 6 inches head room and the second story 13 feet in the clear. There is an opening 42 by 132 feet through the second floor, with two foot bridges across the opening.

The tank shop, besides being lengthened, will have its walls raised to 24 feet 7 inches, which is the height of the walls of the new part. It will have a 30-ton traveling crane and ten tenders will be handled at once in this shop. It is admirably arranged, as will be seen in the detailed description.

An extensive improvement of the main locomotive shop, which combines the machine and erecting shops, was considered, with a view of providing adequate crane service, but the span of the roof, 120 feet, discouraged this for the present. It is now provided with a walking crane through the middle of the building and with small traveling cranes over the repair pits. At some future time this building will be raised or reconstructed in order to provide heavy electric traveling cranes capable of lifting locomotives.

This plant is also the most extensive on the road for the repair of cars. The new building south of the west end of the wood machine shop is for the storage of lumber. It is to be 40 by 140 feet, and the large one between paint shop No. 4 and car erecting shop No. 5 is to be 80 by 302 feet. This is to be divided into smaller shops, the quarter of the length at the north end being divided between pipe-fitting and buffing rooms. The upholstery shop is next, occupying about two-thirds of the length of the building, while the remainder is to be used for varnishing the sashes and blinds of cars. The entire upper story is for the storage of seats, cushions and other car fittings. All of the parlor cars of the road have separate sets of seats for winter and summer use, which necessitates considerable storage room.

In considering the distribution of power it was decided to allow the car department plant to remain as it is owing to the fact that its steam power is produced by the burning of refuse material. There were seven isolated steam plants, including that for the paint mill (building No. 26), which it seemed feasible to replace by a better system, as these all burned coal and involved separate attendance. The increase in the use of compressed air, in lighting and in power involved by the improvements led to the provision of an up-to-date power station in which all the steam, electric, pneumatic and hydraulic power systems will be concentrated. The boiler plant will have three 500-horse-power Babcock & Wilcox boilers with feed-water heaters and mechanical stokers, the draft being provided by a brick chimney, as this was considered a cheaper arrangement than the induced-draft system. The coal storage provides for 180 tons in hoppers in the boiler room. The engines are by the Ball Engine Company, the air compressor by Fraser & Chalmers, with a capacity of 1.500 cubic feet of free air per minute. The generators and motors are by the General Electric Company, installed by the construction department of the Chicago Edison Company.

Work has been started on all of the buildings, but it is now moving slowly on account of the difficulty in securing material. We are indebted to Mr. Robert Quayle, Superintendent of Motive Power of the road, for the plan and Mr. G. R. Henderson, Assistant Superintendent of Motive Power, for the details used in the preparation of these articles.

Twelve-Wheel, Two-Cylinder Compound, Chicago & Eastern Illinois R. R.
Built by the PITTSBURGH LOCOMOTIVE WORKS.

TWELVE-WHEEL TWO-CYLINDER COMPOUND LOCOMOTIVE.

Chicago & Eastern Illinois Railroad.

Built by the Pittsburg Locomotive Works.

This large two-cylinder compound has just been delivered to the Chicago & Eastern Illinois Railroad by the Pittsburg Locomotive Works, and it is interesting as **another example of** the appreciation of the principle of increased locomotive power for the hauling of heavy trains. The Chicago & Eastern Illinois has an exceedingly heavy coal business, and this engine was brought out for this service. It may be taken as an illustration of the wide acceptance of the heavy locomotive as a factor in reducing the cost of transportation.

The total weight is 182,200 pounds and the weight on driving wheels 144,000 pounds. This engine is somewhat lighter than the two-cylinder compounds of the same type built in 1897 for the Northern Pacific (see March, 1897, page 97), which is the design with which it compares most closely. With these weights in view, the heating surface of 2,273 square feet seems small. With but 3,800 pounds more total weight, the Northern Pacific engines have nearly 30 per cent. more total heating surface. The cylinders of the C. & E. I. engine are 21½ and 33 by 30 inches, and the driving wheels 54 inches in diameter. The valves are the American balance type. The following table gives the chief characteristics of the design:

Chicago & Eastern Illinois Railroad.—Weights and General Dimensions of Twelve-Wheel Compound Locomotive.

Fuel	Bituminous coal
Gauge of track	4 ft. 8½ in.
Total weight of engine in working order	182,200 lbs.
Total weight of engine on drivers	144,000 lbs.
Height from rail to top of stack	14 ft. 9¾ in.
Driving-wheel base of engine	15 ft. 6 in.
Total wheel base of engine	26 ft. 2 in.
Total wheel base of engine and tender	54 ft. 6 in.
Cylinders, high pressure, diameter and stroke	21½ by 30 in.
Cylinders, low pressure, diameter and stroke	33 by 30 in.
Slide valves	American balance
Piston rods	Cambria steel, 4 in. diameter
Type of boiler	Extended wagon top
Diameter of boiler at smallest ring	64 in.
Diameter of boiler at back head	72 in.
Crown sheet supported by radial stays, 1¼ in. diameter.	
Staybolts, 1 in. diameter, spaced about 4 in. centers.	
Number of tubes	288
Diameter of tubes	2 in.
Length of tubes over tube sheets	13 ft. 6 in.
Length of firebox, inside	126 in.
Width of firebox, inside	41 in.
Working pressure	200 lbs.
Kind of grates	Cast-iron rocking
Grate area	36 sq. ft.
Heating surface in tubes	2,081 sq. ft.
Heating surface in firebox	192 sq. ft.
Total heating surface	2,273 sq. ft.
Diameter of driving wheels, outside of tire	54 in.
Diameter and length of journals	8½ by 10 in.
Diameter of truck wheels	28 in.
Diameter and length of truck journals	5 by 10 in.
Type of tank	Level top
Capacity of tank, water	4,500 U. S. gallons
Capacity of tank, fuel	320 cu. ft.
Weight of tender with water and fuel	93,000 lbs.
Type of brake	Westinghouse American

INTERSTATE COMMERCE COMMISSION RECORD OF ACCIDENTS IN COUPLING CARS.

Previous to its last annual report the Commission had expressed the opinion that until all cars were equipped, the advantages of automatic couplers as a means of protection to employees would not be demonstrated by the falling off in the number of killed and injured in coupling and uncoupling cars, and that view finds some support in the showing of casualties for the year ending June 30, 1898, when the number killed was 279 and the number injured was 4,988. While 1 employee was killed out of every 349 employed in 1893, and in 1897 the number was 1 killed to 647 employed, the figures were 1 killed to 518 employed in 1898. The ratio of injured to those employed was 1 to 13 in 1893, 1 to 22 in 1897, and 1 to 21 in 1898. In 1899, for which year full returns have not yet been made, it is found that 199 were killed and 5,339 injured upon 89 roads, while in 1898, on the same roads, 209 were killed and 5,484 were injured.

The causes of the large number of deaths and injuries still resulting to employees while engaged in railway operations are believed to be: (1) The increased percentage of inexperienced men employed since the decrease which resulted from the panic of 1893. (2) The greater number of tons carried per man employed, owing to the use of cars having greater weight and greater weight-carrying capacity. (3) The use of old and inferior cars, owing to the unusually great demands for transportation facilities on all roads and in all sections of the country. (4) The transition from the link-and-pin to the vertical-plane type of coupler.

THE BRAKEBEAM SUIT.

Editor American Engineer and Railroad Journal:

Our attention has just been called to a circular issued by the Interchangeable Brake Beam Co. referring to the patent suits pending between this company and that, and we beg to call attention to a material omission in their circular, viz.: They omitted referring to the fact that the case, prior to the date of their circular, was appealed to the United States Court of Appeals and the decision of which court will determine whether "the railroads can use the Interchangeable Brake Beam freely" or not. We think it only proper that attention should be called to the fact that the question is yet to be finally determined, and is still "in the court."

CHICAGO RAILWAY EQUIPMENT CO.

Chicago, February 15, 1900.

EDITORIAL CORRESPONDENCE.

Lake Shore & Michigan Southern.

The new 10-wheel passenger locomotives are continuing to do excellent work, and the freight engines, which we described last month, arrived in the nick of time. There were 25 of them and they came during a violent snow storm and went immediately to work in the emergency without the customary few days or weeks of nursing and petting to break them in. It evidently was a relief to the situation that was greatly appreciated because they gave no trouble whatever and they prevented a blockade of the road.

These engines are remarkably handsome. Their drivers are 62 inches in diameter which, with the exception of the engines built last year for the Lehigh Valley, are the largest ever used for the consolidation type. They are hauling trains of 2,800 and 3,000 tons on the main line, where the maximum grade is not over 16 feet per mile. They have hauled trains of 85 cars which means a total length of over 3,000 feet. The object of the large wheels was to insure speeds as high as made by the ten-wheelers previously in use, while the loads hauled are very much greater. They have already shown the value of this feature, for one was used in an emergency to haul "The Limited," which, we are told, was done in schedule time. Formerly the heaviest main-line freight engine was a 19½ by 30 in. ten-wheeler with 62 in. drivers and a total weight of 156,000 lbs. and 117,000 lbs. on the drivers. The new consolidation engines have a total weight of 168,000 lbs. with 149,000 lbs. on the drivers and 21 by 30 inch cylinders, and the same sized drivers as the lighter engines. In order to provide for the stresses due to 21 inch cylinders the main driving axle journals are 9½ by 12 in., which is one inch larger in diameter than the other journals. The total weight of these engines was limited to 172,000 lbs. The driving box brasses are relieved for about 1¼ in. on the main journals and 1½ in. on the others after the manner of truck brasses in order to reduce the area of contact between the brasses and the journals to that which really supports weight. The passenger and freight engines steam well and are very satisfactory. They exhibit the greatest saving in weight by the use of cast steel and the reduction of sections that is to be found, and they represent the maximum power that could be had with this weight.

Chicago & Northwestern.

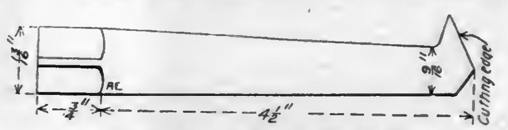
This road, in common with a number of western lines, is having difficulty just now in securing the grade of coal which they have been using, and for which their fireboxes are adapted. The reason for this is not as important as the effect upon the cost of the fuel and its action in the engine. The coal now received, and it is the best obtainable under the circumstances, though costing less than that formerly used, is really much more expensive because a great deal more is required. This points forcibly to the very great importance of the adaptation of the grates to the fuel, and not only to one particular kind of fuel. It is necessary to have more leeway in the choice of fuel, so that a variation, within reasonable limits, may be provided for to meet the requirements of the coals that are available. Mr. Quayle is rather more interested in the width of the firebox as a result of having to get along with poor coal for a while. He spoke with considerable favor of a moderate increase in grate area through an increase in width. It is not necessary to go to the large grate areas used in the East for culm burning, but we may expect to see a rational treatment of the wider firebox in the West in the near future.

Mr. Quayle and his assistant, Mr. Henderson, are very carefully watching the failures of locomotives on the road by means of reports returned by the division master mechanics. These reports are tabulated, and every six months the breakages are analyzed and discussed in a meeting of the officers of the department. This has resulted in a large reduction in engine failures, due to the information obtained in regard to the weakness which service develops.

The bulging of the side sheets of locomotive fireboxes has been investigated by Mr. G. M. Davidson, Chemist and Engineer of Tests of this road. He believed that the bulging of the sheets between the staybolts was one effect of the water used to wash out the boilers while hot, and proved his point. Four 24-inch square sheets of ⅜-inch boiler plate were cut, and one of them was secured to another, but thicker sheet, by staybolts as in the case of a firebox. The sheets were heated just below a cherry red and cooled by the application of a jet of cold water at the center. One of the sheets had two, one had six, and the third, twelve heatings and coolings. There was no application of exterior force, yet the sheets bulged under the stresses of contraction. The first bulged at the center to a height of about 2 inches, the second 5 inches, and the third 8 inches, showing the relative effects of two, six and twelve coolings. The sheet that was secured to another sheet, as in a firebox, was heated and cooled five times by the jet at the center, and afterward five times with jets in the four corners. The first treatment caused an outward bulge at the center, but this was drawn in by the other coolings until but a slight bulge remained. At the four corners, however, there were pronounced bulges, identical in appearance with those found in fireboxes which are worked hard in service. The staybolts were all loosened so that they would leak if put under pressure; but it should be clearly understood that the stresses in these experiments were entirely and solely those due to expansion and contraction. The conclusion drawn is that cold water injures firebox sheets and that the bulging so often found is probably due to this cause. It may be prevented, or at least improved, by furnishing enough engines so that the time for cooling off may be allowed before washing out. This, however, may be much more expensive than the frequent replacement of the side sheets.

Two new methods of removing fireboxes are being developed on this road. In both of these, pneumatic drills are employed to drill into the staybolt through the outside sheet. Then in one of the methods a tool made somewhat like this sketch is placed in the drill hole and, driven by pneumatic power, it cuts off the staybolt at the bottom of the drilled hole.

The other method is even simpler than this. The staybolts are drilled through the sheet as before, the hole being ¾ inch, or larger, according to the size of the staybolt. A punch like those used by blacksmiths is then inserted in the hole, and when struck a blow with a sledge, the bolt breaks off. We have no record of the time required for this method, but for the first it is stated that when cut out in the old way, with



Device for Cutting Staybolts.

a chisel and sledge, 90 man-hours were required for a firebox containing 896 staybolts. This has been reduced to 15 man-hours by the use of the new tool illustrated. With smaller fireboxes the time is much shorter. One man now does the work alone, and any portion of a side sheet may be removed without taking out the mud ring or the back head.

Mr. Henderson has worked out an usually complete individual record for locomotives, giving the characteristics of each class and the special equipment. It has 11 columns to record changes when repaired. He has also compiled a record of machine tools in the possession of the road, giving the original cost, size, age and present value of each, the name of the maker, and shop in which it is used. He has made a simple improvement in ordinary shop air hoists for the purpose of cushioning the upward motion, in order to prevent the piston from striking the upper head hard enough to cause the load

to jump off the hook. He merely drills a small hole in the top head to allow the air above the piston to escape slowly, and the cylinder thus acts as a dash pot to stop the motion gradually.

Columbus, Hocking Valley & Toledo.

This company has just completed a large coach paint shop, adjacent to their repair shops, which is a great improvement over the previous arrangement, in which the painting was done at a distance of several miles from the main locomotive repair works. The freight equipment is being overhauled, a large number of large-capacity cars have been built, and many light engines with 16-inch cylinders are being increased in power by the building of larger boilers and the use of larger cylinders. This is essentially a coal road, and the passenger business is relatively light. Mr. Stiffey, Superintendent of Motive Power, has recently fitted up the entire plant with air pipes, and pneumatic power will be used for all work to which it is adapted.

This road has been testing Lucol spraying paints with great satisfaction because of the rapid work which its use permits. This spraying paint "sets" more rapidly and it covers more area than other paints. Cars are not detained as long as before because they are finished very quickly. In most cases one coat of the Lucol is sufficient, and answers for two coats of some other paints, and thus the car is kept out of service for painting but 12 hours instead of 24. It is common practice to paint and letter a car in 12 hours at these shops. The tests on this road were made out in the weather when the temperature was 10 degrees below zero. Under such severe conditions there was no sign of crawling or crinkling of the paint on the iron work or on the galvanized-iron roofs, as would be seen with linseed-oil paints.

GRAPHICAL TREATMENT OF HELICAL SPRINGS.

By Edward Grafstrom.
Mechanical Engineer Illinois Central R. R.

In the "American Engineer and Railroad Journal" of December, 1898, page 396, and following, Mr. F. J. Cole had an interesting article on "Springs," in his series on "Locomotive Design," and many readers have probably found the diagram of working loads and deflections for semi-elliptical springs very convenient and useful in proportioning springs of this kind. The writer regretted at the time the paper was published that a similar diagram had not been furnished for helical springs, for which the mathematical formulas are perhaps still more unwieldy than for the elliptical ones. Since then there have appeared, in several European papers, diagrams for similar

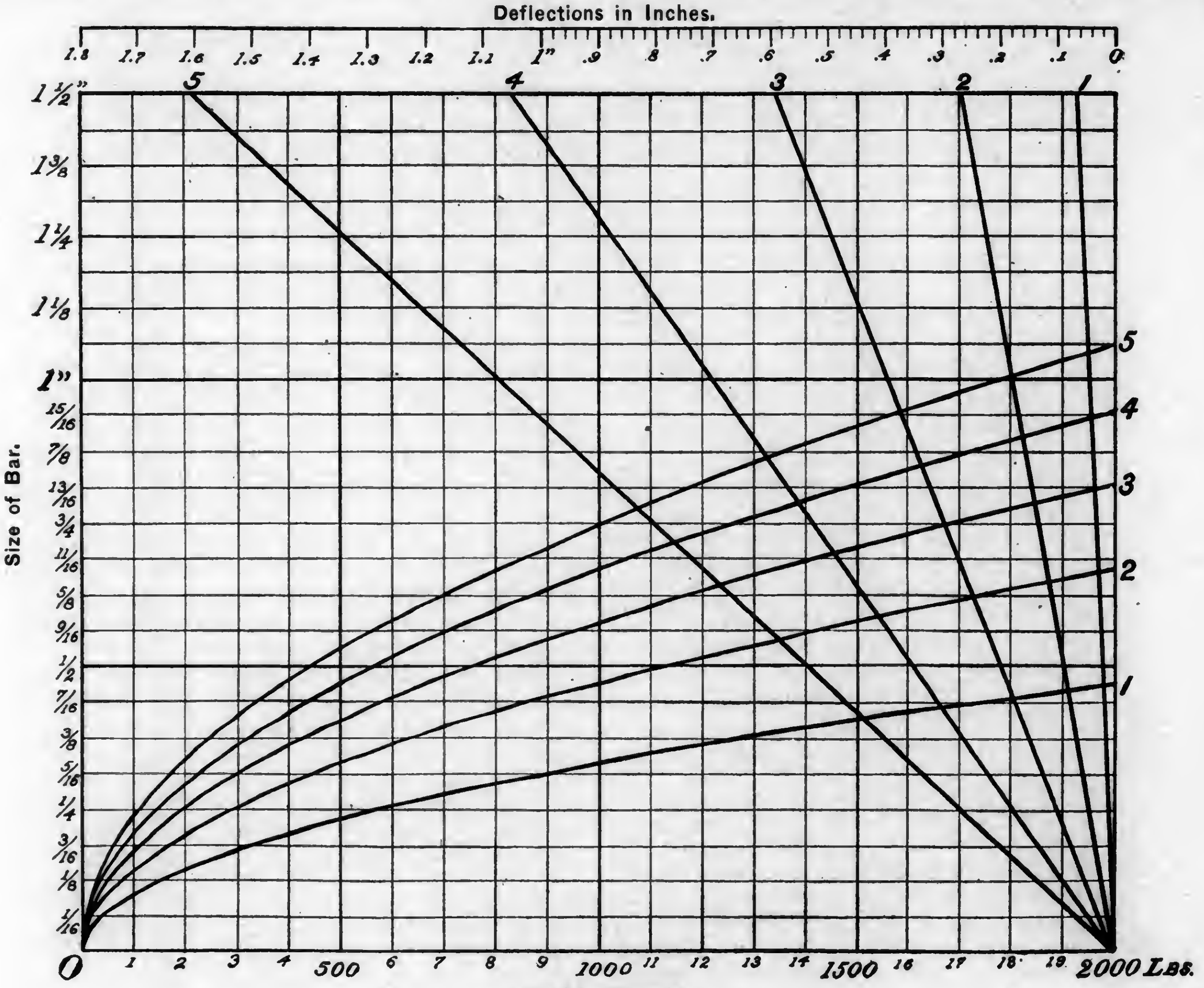


Diagram of Working Loads and Deflections of Helical Springs.

formulas, and as such diagrams can be adopted to graphically illustrate the expressions of which Mr. Cole made use, the writer submits an example herewith, believing it to be original, at least as far as the deflection is concerned, and hoping that it will be found a useful adjunct to Mr. Cole's excellent article.

In order to understand the development of the diagram, the following explanation will be necessary. The symbols are the same as used by Mr. Cole, viz.:

$P =$ working load.
$d =$ diameter of steel bar.
$R =$ radius to center of coil.
$D =$ deflection of spring under working load.
$G =$ modulus of shearing elasticity, 13,000,000.
$L =$ length of bar before coiling.
$S =$ working shearing fibre strain, 45,000 pounds.

M = number of coils.

Considering now the first formula used by Mr. Cole:

$$P = \frac{S\pi d^3}{16R}$$

it can be re-written thus:

$$P = \frac{\pi}{16} \cdot \frac{d}{R} \cdot S \cdot d^2.$$

By calling the expression

$$\frac{\pi}{16} \cdot \frac{d}{R} \cdot S = C,$$

we get $P = C \cdot d^2$, which will be recognized as the equation for the parabola, whose curve can now easily be drawn by inserting the numerical values of π and S, and assuming a certain ratio for R : d. In the accompanying diagram this ratio has been taken as 1, 2, 3, 4 or 5, and five parabolic curves drawn accordingly, with the point O as vertex, P marked off along the abscissa, and d measured on the ordinate.

For the deflection Mr. Cole uses the following formula:

$$D = \frac{2RSL}{dG},$$

and for L the equation $L = M 2\pi R$.

By combination we then get:

$$D = \frac{2RS \cdot M . \pi R}{d\ G},$$

which expresses the total deflection in the whole spring.

In order to reduce it to deflection per coil, M will now be dropped:

$$D = \frac{2RS \cdot 2\pi R}{d\ G}.$$

Dividing this by d, carrying out the multiplications, and re-writing the equation, we get:

$$\frac{D}{d} = \left(\frac{R}{d}\right)^2 \cdot \frac{4\pi S}{G}.$$

After inserting the numerical values of S, G and π, it appears thus:

$$\frac{D}{d} = \left(\frac{R}{d}\right)^2 O, 0435.$$

It will now be seen that this is the equation for a straight line forming with the ordinate an angle, the tangent for which is equal to O,o435 multiplied by the square of the ratio between R and d. Assuming this ratio as before to be 1, 2, 3, 4 or 5, five straight lines have been drawn on the diagram, for convenience's sake with negative abscissa from the lower right hand corner, and the scale for measuring the deflection has been drawn above the diagram in decimals of inches in order to be comparable with Mr. Cole's table for the deflections of helical springs. By multiplying these deflections by the number of coils the total deflections of springs can be obtained.

As an illustration of the use of the table, we will select a spring for a load of 1,500 pounds, and suppose that space makes the ratio R : d = 4 most suitable. By following the vertical line drawn through the 1,500-pound mark until it cuts the parabola marked 4, and then following a horizontal line through this point to the left margin, we come to the 13/16-inch mark, which is then the diameter of the bar. The same horizontal line cuts the angular line marked 4 at a distance from the right hand margin, which projected on the decimal scale at the top gives us 0.57 inch, which is thus the deflection per coil.

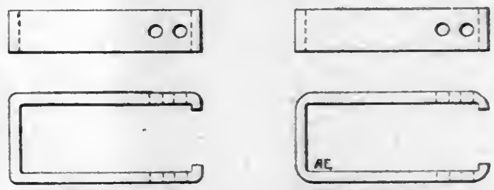
For comparing the results obtained from the diagram and the table, we will take a spring of ¾-inch steel and 5¼ inches outside diameter. The diameter at the center of the coil is then 5¼ — ¾ = 4½, and R is consequently 2¼ inches, which, divided by ¾, gives a ratio of 3. By following the horizontal line through the ¾-inch mark, we find that it crosses the parabola marked 3 between the vertical lines drawn from the 1,600 and 1,700-pound mark, nearer the latter. This gives then the capacity of the spring. We also find that the same horizontal line intersects the angular line marked 3 in the same point. The distance from this point to the right hand margin, projected on the scale above, gives a deflection of very nearly 0.3 of an inch. Comparing these figures with those in Mr. Cole's table, we find that the corresponding values are given as 1,657 pounds and 0.293 inch.

It should be said in conclusion, that the diagram is based on an average fibre strain of 45,000 pounds, whereas in Mr. Cole's table the fibre strain varies from 40,000 to 50,000 pounds, which makes a small difference in comparing the values obtained from the diagram and from the table.

WEAKNESS OF DRAWBAR YOKES.

An important improvement in the construction of drawbar yokes was made several years ago by the Cleveland City Forge & Iron Company. It is now an absolute necessity in view of the present situation with regard to draft gear. The attention of a representative of this journal was directed to the difference in the draw bar yokes as made by usual methods, and by the special method used by the firm referred to. This led to a personal examination of the manufacture at their works, which led to the conclusion that the process is not generally known. Those who know about it buy no other yokes though the price is higher.

At a recent meeting of the Central Railroad Club, Mr. West of the New York, Ontario & Western stated that upon replacing



Full Corners. Weak Corners.

Improvement in Drawbar Yokes.
Cleveland City Forge & Iron Co.

the original tail pins of the draft gear on that road with yokes, nearly as many breakages occurred as before, although the yokes were made of 1 by 4 inch iron. The back ends, which were presented to the followers, broke away from the two parallel side portions. This was thought to be due in some cases to the iron being "red short" and when bent the temperature was such as to start cracks at the corners. The shocks and stresses of service soon finished the fractures.

The fundamental trouble, however, is with the shape of the bends. If the M. C. B. lines are followed, it is necessary to make a short bend at the corners, and notwithstanding the recent increase in the radius from ¼ to ⅝ in., the short bend as ordinarily made reduces the thickness of the iron at the angle, some, recently examined, being reduced to ¾ in. and less. Mr. West referred to the fact that the Cleveland City Forge & Iron Company was manufacturing yokes in which the difficulty was overcome, and Mr. Waitt immediately stated that purchasing yokes from these makers probably accounted for the fact that the Lake Shore had been entirely free from the trouble.

The increased radius helps a little, but it remains impossible to avoid thinning the metal down unless it is specially provided for in the forging. The yokes referred to thus favorably are made in two operations. The first bends the yoke roughly to shape and the second presses it into final form over a mandrel. This is done in a specially powerful forging press, and the clearances are made in such a way as to upset the metal so as to fill out the corners and it is upset only at the corners. By this method the section of the iron at the corners is increased over the original section, and this will be readily seen to be a decided advantage, as it furnishes the largest section where it is most needed.

COMPOUND LOCOMOTIVES.

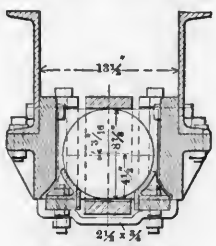
Disposition of Steam in the Two-Cylinder Type.

Mr. F. W. Dean, in discussing locomotive practice, before the New England Railroad Club, stated that he regarded the compound principle as "the greatest improvement that has been introduced into the motive power departments of railroads."

This is the greatest improvement in such engines that has been made since locomotives were first built, for two reasons; first, because it is the only improvement in principle that has been widely applied, and second, because it is the only fundamental means of economy of fuel and water that can be applied. That it is successful in realizing economy is no more a matter of doubt than that the sun shines.

A type of engine that can save nearly one-quarter of the coal now used by simple locomotives; that reduces water consumption by 15 to 20 per cent.; that steams better than simple engines in hard places; that reduces smoke, cinders, and the fire risk; that diminishes boiler and slide-valve repairs, and that does not necessarily increase repairs of any kind, must be adopted as soon as it is intelligently designed and prejudices are relegated to the background. . . .

The question as to the type of compound locomotive is likely to arise frequently, and it can be laid down as a safe belief that the two-cylinder compound is more economical than that having any greater number of cylinders, for the reason that it has the least surface for condensation per unit of piston displacement. In large sizes, however, except for freight service, it is difficult to obtain sufficient port area for the low-pressure cylinder unless a departure is made in the valves from the ordinary practice. In fast work I believe that such engines will not be as economical as we have a right to expect unless a departure is made. The loss of work between the cylinders will counteract the economy to a greater or less extent than is due to the compound principle.



Section at A-B

The effect of the compound principle is persistent, and its economical result cannot be prevented except by the introduction of phenomena that come from improper designing. The defect above all to be avoided is the loss between cylinders is so insidious, so to speak, and so little comprehended, that it should be dwelt upon sufficiently to make its causes and nature clear. It cannot be done away with, even in slow-running pumping engines, for even there some work must be absorbed in transferring the steam from one cylinder to the other. In addition to this cause, the various resistances produced by obstructions and abrupt changes in direction of the steam passages are to be noted. The steam in passing out of the first cylinder through the intercepting valve, where this is used, and through the open port of the low-pressure cylinder, is considerably retarded, and a loss of pressure is produced. Engines having piston valves suffer from this loss because the steam has to pass through gratings which form the ports. Engines that have the intercepting valve on the low-pressure side are much subject to this loss, because the steam is rapidly drawn from the receiver by the low-pressure piston through this restricted opening. If this valve is on the high-pressure side, the steam passes through it only as rapidly as it escapes from the small cylinder, and this is only some one-half to one-third as rapidly as it is drawn into the large cylinder. This shows the importance of placing the intercepting valve as near the high-pressure cylinder as possible.

Having considered this loss, we are in a position to appreciate the reason why certain compound locomotives are highly economical, when working slowly, or even moderately fast, with heavy trains. In these cases, in consequence of late cut-offs, yet with considerable expansion and somewhat slow movement of the steam, the losses described are small, and bear a small proportion to the total work done. The result is that the compound is enabled to bring out its valuable qualities undiminished.

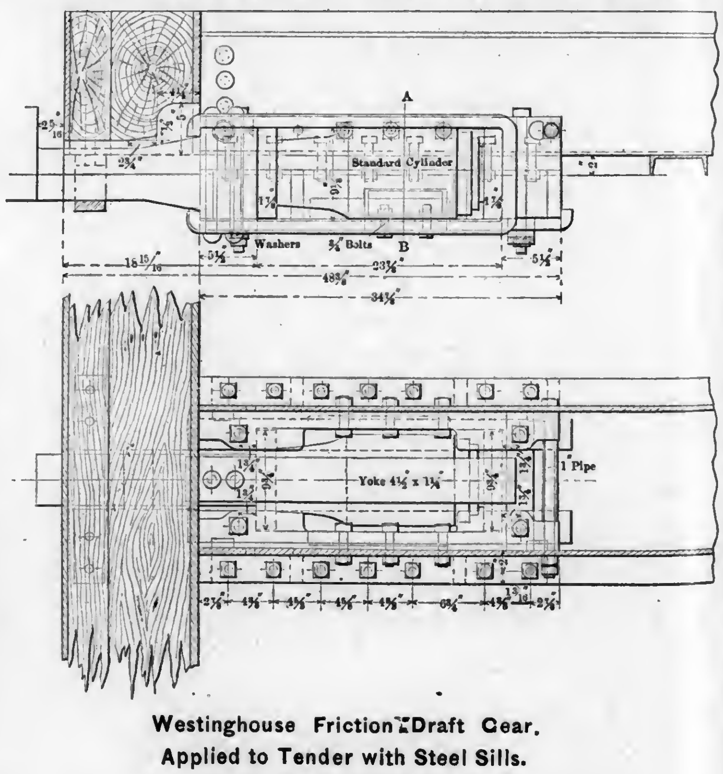
Most compound locomotives have a low-pressure port ridiculously small, so small, in fact, that, while simple engines require an extravagant velocity of steam through ports, even as high as 1,500 feet per second, some compounds have it two or three times as great. In such locomotives the loss between the cylinders is enormous, and the engine becomes useless for high speeds.

WESTINGHOUSE FRICTION DRAFT GEAR.

Applied to Tenders of the Union Railroad, Pittsburg.

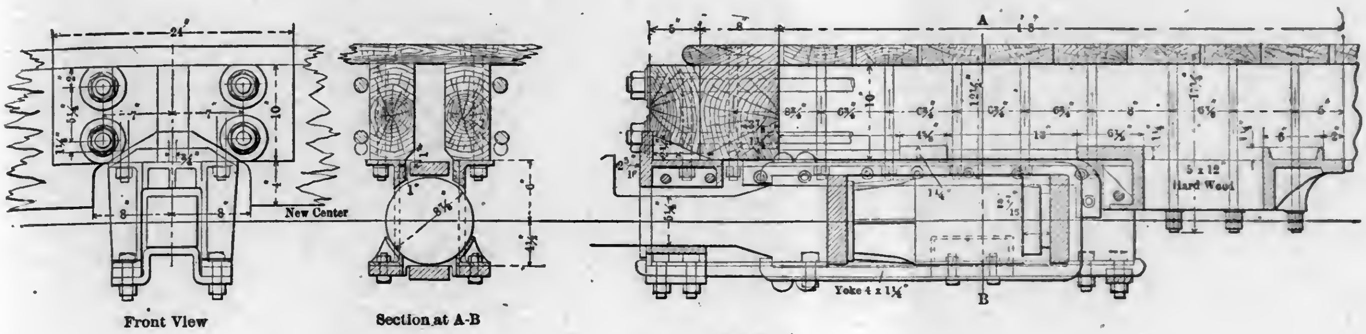
One effect of the use of cars of large capacity and the recent introduction of exceedingly powerful locomotives is to direct attention to the weakness of the draft gear on cars and also on locomotive tenders, which is becoming serious because of the expense of repairs. The relief most naturally sought by railroad men is the increase of spring capacity in the draft rigging; but this, while improving the strength of the gears, introduces what is believed to be a serious difficulty, that of an increased liability of breaking the trains in two on account of the reflex action of these heavy springs when the load, either in tension or compression, is suddenly removed. This occurs in hauling trains out of "sags," and it points toward the desirability of improving the draft-gear capacity in some other way. The ideal plan for very heavy stresses seems to be one which greatly increases the resistance in both pulling and buffing without subjecting the parts to the sudden shocks of greater spring power. This is done by the Westinghouse friction draft gear, which we shall describe in detail in a future issue. This device provides that which has not been accomplished in any other way. It furnishes enough spring power and incidentally takes care of the very heavy stresses which heavier springs do not appear to be well adapted to handle, and it does this without endangering the equipment by excessive recoil.

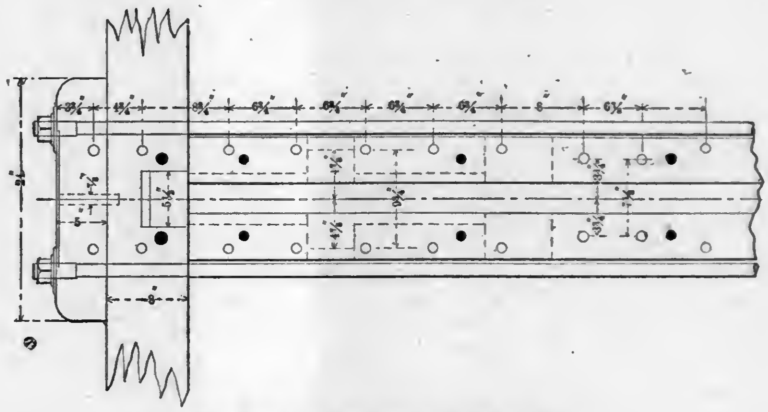
The very large consolidation locomotives built in 1898 for



Westinghouse Friction Draft Gear.
Applied to Tender with Steel Sills.
Union R. R., Pittsburgh.

the Union Railroad by the Pittsburg Locomotive Works, and illustrated in our issue of November, 1898, page 365, had exceptionally strong tender draft gear, but after running a number of months it was found necessary to substitute the Westinghouse draft gear, as shown in one of our engravings. This is an example of its attachment to steel center sills, which were orginally placed 13½ inches apart, and while not specially designed for its reception, the equipment goes in very nicely. It is held by heavy castings bolted by a number of ⅞-inch bolts to the lower flanges of the large steel channels. This is a very simple and strong arrangement, making use of 20 close-fitting bolts to take the stresses of the stops. The





Westinghouse Friction Draft Gear.
Applied to Tender with Wooden Sills.
Union R. R., Pittsburgh.

stops are 1⅞ by 9¾ inches. The construction is so clearly shown in the engraving as to be fully understood without further description. These engines have 23 by 32-inch cylinders, and the weight on driving wheels is 208,000 pounds, from which a good idea may be had of what the draft rigging is called upon to do. This coupler has a specially strong shank for attachment to the draft rigging.

The other drawing shows the application of the draft gear to the tenders of the switching engines on the Union Railway, Pittsburg, illustrating its attachment to wooden sill construction, and it is specially interesting because of showing how existing wooden structures may be adapted to receive it. In this case the casting containing the friction gear is supported by a cast saddle, which is bolted to the lower flanges of the two 10-inch channels, the webs of which are cut away to receive the barrel. These channels are bolted to the bottom faces of the wooden center sills, as shown in the sectional view. The front view illustrates the substantial carrier casting, which is also shown in the longitudinal section, where its attachment to the end sill is seen. The yoke attachment is of 4 by 1¼-inch iron and the draw-bar stops are unusually large. In the end view the ends of four large through rods are shown. These were used in connection with the draft gear with which the tenders were originally fitted. The lower rods were raised a little over one inch to accommodate the Westinghouse attachment. Attention is directed to the very large keys let into the end sill and the center sills over the draft gear, and to the large bracket castings at the rear of the whole rigging; also to the 5 by 12-inch oak blocks placed between these brackets and secured by bolts to the bottom faces of the center sills. The inner brackets butt against the center plates. The upper flanges of these castings are let into the bottom faces of the sills, and they act as keys 1¼ inches thick to assist in transmitting the stresses to those large timbers. This draft gear was applied to these tenders to obviate serious difficulty in regard to the ordinary gear, which required a large amount of repairs, and since this change there has been no trouble of any kind. The coupler shank is changed somewhat from the usual form to make it stronger where it connects to the yoke. With ordinary devices the coupler is much stronger than the draft gear, while with this equipment the order appears to be reversed.

It is impossible to give at this time exact comparative statements of the cost of maintenance of the Westinghouse friction draft gear with other draft gears because, so far as we know, no record has been kept of the time the equipment has been held idle in the shop for the repairs of the ordinary draft gear to be made. A statement is at hand, however, from a railroad in Pennsylvania, from which it is learned that seven six-wheel connected engines, operating with rigid draft gear on the tenders, showed an actual cost for repairs of the draft gear and end sills of 81 cents per 1,000 miles run; while four engines of exactly the same class, equipped with the Westinghouse friction draft gear, have made a record of 76,800 miles since being thus equipped, without costing anything for repairs of these parts. This is a saving of 81 cents per 1,000 miles, or a total of $62.20 in favor of the friction draft gear in this mileage, which was made in six months, and in very severe service.

On this same road two exceptionally heavy locomotives, put into service some time ago, were fitted with specially strong tender draft gear, designed with reference to the service by the builders, and after running 35,856 miles without expense for repairs it was found necessary to replace the draft rigging with the friction device. These two engines have since made a combined mileage of 23,364 miles with the new gear without any repairs, and the parts now appear to be in as good condition as when the change was made. Some idea of the service may be had when it is stated that these engines are capable of exerting a draw-bar pull of over 50,000 pounds.

A 100,000 HORSE POWER CENTRAL STATION.

The power station of the Third Avenue Railroad of New York is to have the greatest power producing capacity ever assembled in one place. It is now under construction, and according to "Power," the capacities, as far as they have been decided upon, will be as follows:

Boilers, number	60
Boilers, capacity, each, rated	520 H. P.
Boilers, aggregate capacity, rated	31,200 H. P.
Boilers, heating surface	312,000 sq. ft.
Working pressure	200 lbs.
Engines, number	16
Diameter high-pressure cylinder	46 in.
Diameter low-pressure cylinder	86 in.
Revolutions per minute	75
Aggregate area high-pressure pistons	26,590 sq. in.
Aggregate area low-pressure pistons	92,940 sq. in.
Aggregate area both pistons	119,530 sq. in.
Horse power, rated, each	4,500
Horse power, rated, total	72,000
Horse power, maximum, each	7,000
Horse power, maximum, total	112,000
Ratio, maximum to rated	1.56

The plant will have the capacity to carry a sustained load of 100,000 H. P. The consumption of coal will be about 75 tons per hour when running at full capacity. An idea of the engine capacity is given by the statement that if all of the piston area was combined in a single cylinder it would have a diameter of 32½ feet. The contract for the boilers has been closed with the Babcock & Wilcox Co. They will be placed in two stories of the building and provided with automatic coal and ash handling machinery and Roney stokers.

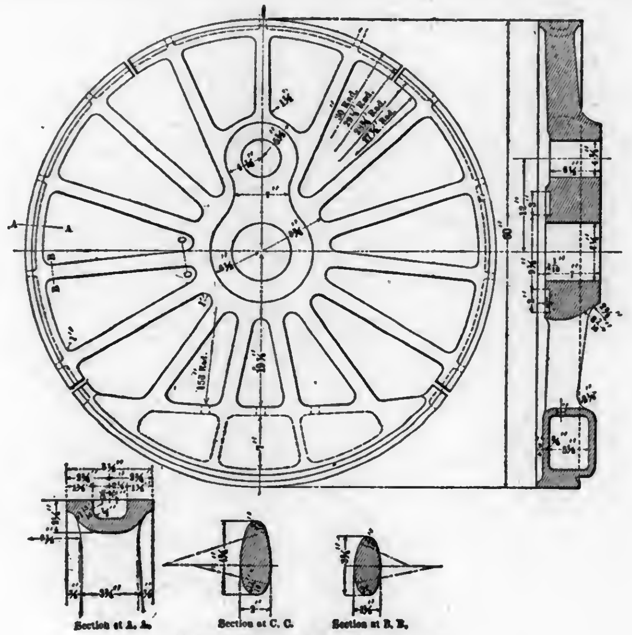


Fig. 1.—D. G. R. & W. Ry.

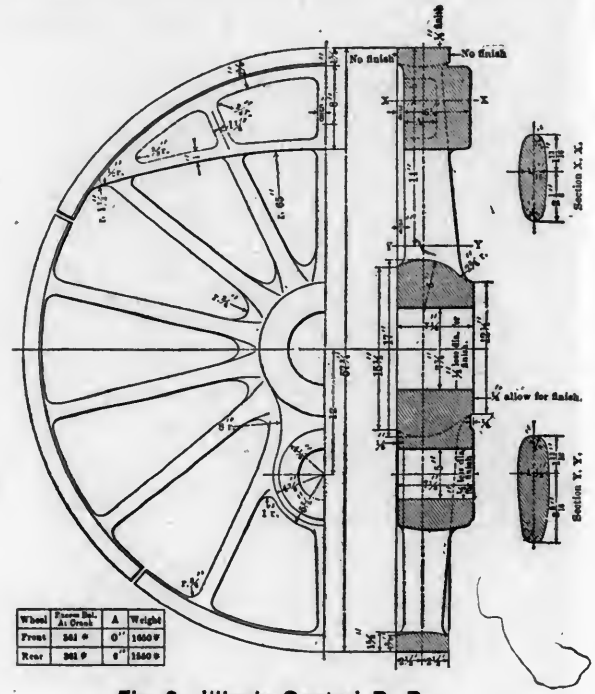


Fig. 2.—Illinois Central R. R.

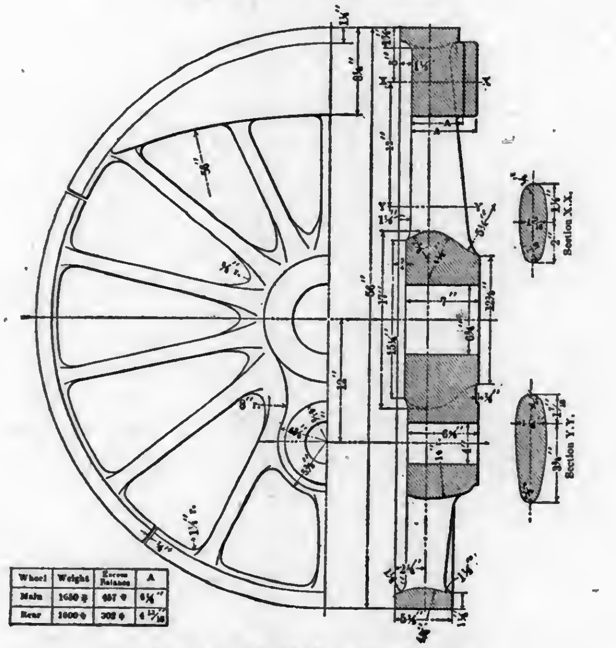


Fig. 3.—Texas & Pacific R. R.
(The weight of the rear wheel is 1,600 lbs., not 1,000, as indicated in the cut.)

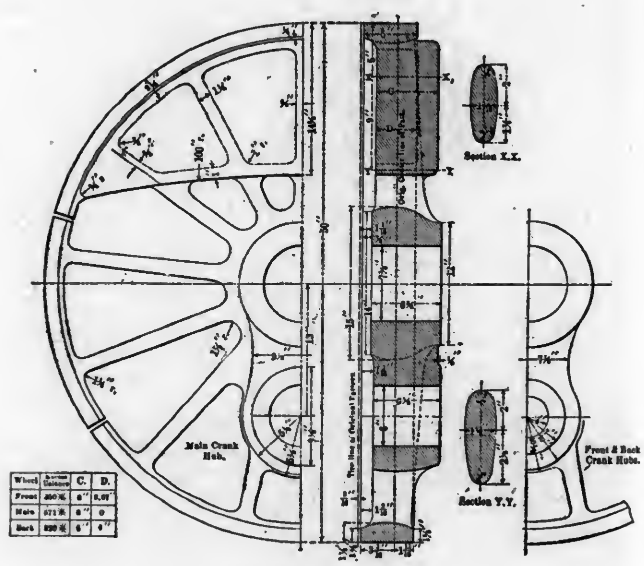


Fig. 4.—Wisconsin Central.

CAST-STEEL DRIVING WHEELS.

Last month we printed a number of drawings of cast-steel driving wheels to show the possibilities of weight saving. The drawings which are now presented bring out other features. They show six designs of cast-steel driving wheels made by the Sargent Company of Chicago for as many different railroads. These range in diameter from 44 to 60 inches, and the weights are given in most of the engravings.

Attention should be directed to the location of the divisions in the rims of cast-steel wheels. These are for the purpose of disposing of the internal stresses in the castings due to the unevenness of section through various parts of the wheel. The rim should be cut on both sides of the spokes running into the crank hub and into the counterweight. The reason for this is clear, but it is not always remembered by the draftsman in designing driving wheels. Wheels have been made successfully without cutting the rims, but it is believed to be safer to cut them.

There are differences of opinion with regard to the best shape of spokes. Some of the locomotive builders, notably the Baldwin and Schenectady, appear to favor the elliptical section, while others, the Brooks, prefer a nearly rectangular form. Both are successfully cast, although the rectangular spoke appears to have been a little more difficult to manage in the foundry at first. The foundrymen now seem to have no preference. As a matter of taste, the rectangular form is more graceful in appearance and it has the important advantage of rendering the parts covered by the driving wheels more accessible. Various forms of spokes are seen in the illustrations of last month, and in the present article, and the light, open appearance of those of rectangular form is very marked.

There is a strong inclination on the part of steel makers toward solid hubs, both for the axle and the crank pin. The form of counterbalance weight shown in Fig. 2, the Illinois Central 57¾-inch wheel, the Wisconsin Central 50-inch wheel, Fig. 4, and the Texas & Pacific 56-inch wheel, Fig. 3, is also strongly advocated. These wheels are made with the counterbalance weights open on one side. If the steel makers receive

the proper information from the railroads, the metal in the counterweights may be calculated very closely, so that very little or no additions need be made in the shops. Some wheel centers are made entirely without counterweights, as in Fig. 5, the Union Pacific wheel. This requires the use of blocks. Other designs require box forms of the castings, in which large cores must be supported, and some require centers with large pockets for the counterweights, with very limited openings for the venting of the cores. These castings are difficult to make on account of the danger of blow holes. For insuring sound castings, the open design is preferred. If box-shaped counterbalances are required, the cores should be vented through large openings in the rim and inside plate.

The question of the steel to be used may safely be left to reputable makers, and it is not wise to hamper them too much with special requirements, although it is a good plan for the purchaser to keep close track of what he is buying. Acid open-hearth steel, with a composition as follows, has been found to give satisfactory results for locomotive parts, including wheel centers:

Carbon, 0.25 to 0.30 per cent.

Manganese, 0.60 to 0.80 per cent.

Silicon, 0.25 to 0.35 per cent.

Sulphur and phosphorus, below 0.04 per cent.

Some time ago the Sargent Company made a comparison between annealed and unannealed pieces cast from the same heat, with the following results:

	Tensile strength lbs. per sq. in.		Elongation in 8 inches.		Reduction of area.	
Spec.	Unann'l'd.	Ann'l'd.	Unann'l'd.	Ann'l'd.	Unann'l'd.	Ann'l'd.
4,530	61,740	60,000	18.5%	25.75%	22.2	51.15
4,531	68,500	67,500	22 %	30 %	26.3	46.25

Chemical Composition.

Specimen.	4,530	4,531
Carbon	0.28%	0.27
Manganese	0.78	0.74
Silicon	0.26	0.29
Sulphur	0.046	0.049
Phosphorus	0.028	0.028

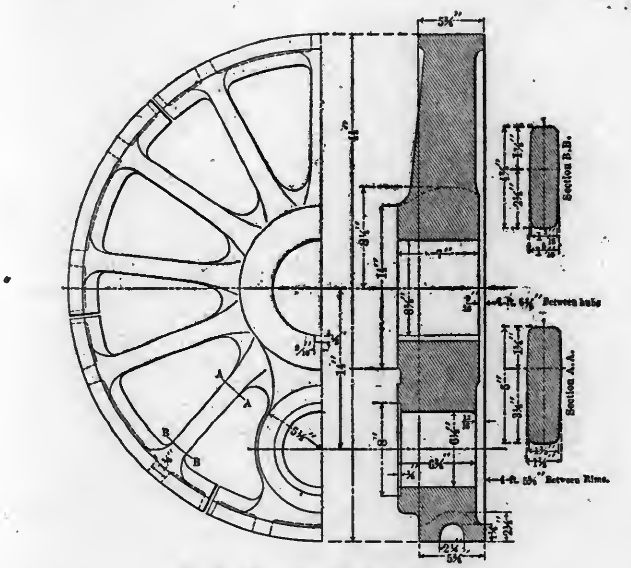


Fig. 5.—Union Pacific Ry.

The fracture of the unannealed specimens was crystalline, which, in the annealing, changed to a silky appearance. This steel, when unannealed, is up to the ordinary specifications, although the reduction of area is rather low. This material is believed to be excellent for wheel centers. As a guide to those who are preparing specifications for cast steel, the following are recommended as having been found satisfactory for driving-wheel centers and other cast-steel parts:

Specifications for Steel Castings.

1. Castings must be true to pattern, sound and solid, free from sand, slag, scale and shrinkage cracks, and all fins and risers must be trimmed off in a workmanlike manner, and the castings have a reasonably smooth surface.

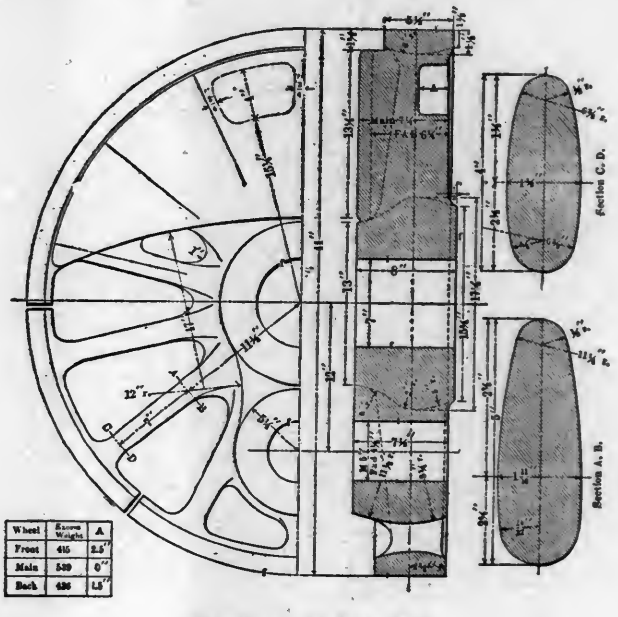


Fig. 6.—C. I. & L. Ry.

2. All castings must be annealed unless otherwise specified.

3. All important and very large castings should have a test coupon attached to them of sufficient size to furnish two pieces for test. For smaller castings, where it is not practicable to attach test coupons, test bars may be cast separately for each heat, and their record will be accepted as representing the metal in the castings, provided they have been annealed with the pieces they represent.

4. A test bar cut from the coupons and turned up with a test section ½ inch in diameter and 2½ inches long between the shoulders, must show a tensile strength not less than 60,000 pounds per square inch, and an elongation not less than 20 per cent. in two inches.

5. All important castings should bear designating mark of the steelmaker.

By far the most handsome calendar yet received at this office for the year 1900 is that of the J. G. Brill Company, the well-known car and truck builders, Philadelphia, Pa.

A munificent gift of $50,000 was recently made to the Massachusetts Institute of Technology by Mr. Augustus Lowell. This gift is to be used in establishing a retiring fund, the income of which is to be given to the teaching staff of the institute in case of illness, death or retirement.

A new lubricated center plate for cars has just been patented by Mr. Clement F. Street, Manager of the Railway Department of the Dayton Malleable Iron Co. It involves no complications whatever, but by its form permits of oiling conveniently and retains the oil indefinitely. When its importance becomes appreciated this device will be in great demand.

A remarkable record was recently made by one of the Schenectady compound locomotives of the Minneapolis, St. Paul & Sault Ste. Marie R. R. Co., on a run between Harvey and Camden Place, a distance of 627 miles. The train pulled by engine 520 consisted of 9 cars of about 39 tons each. The run was made in 12 hours and 5 minutes, including stops. The stops were 55 in number and an average of 7.14 miles per stop. The maximum speed was 67 miles per hour and the average 52 miles per hour. This run is a continuous and regular one for these engines and it is reported that hot driving boxes are practically unknown among them.

PORT OPENINGS AND MOTION OF PISTON VALVES.

By C. A. Seley,

Mechanical Engineer, Norfolk & Western Ry.

The advent of the piston valve in locomotive design brings up the question as to whether there should be any change in the adjustments of the valve motion work from that of slide valves on engines, similar in other respects, but which are equipped with piston valves. It would seem to be a question in which the area of the port opening should be considered.

Piston valves thus far noted have a circumference equal to about twice the length of the port as used with a slide valve, and when working at a short cut-off and partial port opening, give from 50 to 75 per cent. greater port area than is obtained with the slide valve. In making this statement bridges have been allowed for in the piston bushing.

Properly constructed piston valves, being perfectly balanced, do not spring or wear the motion to the extent suffered by their older competitors and adjustments made can be counted upon to last for a much longer time.

The last few years have seen a radical change in opinion regarding full gear lead, and competent authority only recognizes it as a measure by which to obtain proper lead in running positions. There is not so much difference of opinion on the latter point as to amount but more as to the best method of getting it. In Halsey's "Locomotive Link Motion" the methods of a number of leading roads to attain proper lead are given, from which it will be noted that ¼ inch at one-fourth cut-off is recognized by the majority as a standard. With ¼-inch lead and a 16-inch port the area of the opening would be 4 square inches, using a slide valve, while a 10-inch piston valve will give about 6 square inches. This opening begins when the crank is about 20 to 25 degrees from the dead center before the forward stroke of the piston and with a piston travel of, say, 30 inches, the piston has yet about ¾ inch to travel.

Experiments are necessary to determine the point but it is possible that the lead of engines with piston valves may be such as to give less than ¼ inch at one-fourth cut-off with best results in wear of pins, boxes and life of frame bolts and connections. Although there is greater available port opening, yet it must be borne in mind that reduction of lead for a given cut-off reduces also the maximum port opening following. For this reason experiment rather than theory will give the desired information.

Prior to the adjustment of some engines which are to be equipped with piston valves, it was thought desirable to thoroughly investigate the valve motion which has been in use on other engines of the same class using slide valves. The principal dimensions are as follows: Cylinder, 21 by 30 inches; steam ports, 1⅝ inches; steam lap, 1⅛ inches; exhaust lap, line and line; diameter of piston valve, 10 inches; radius of link, 46 inches; offset of link saddle pin, 15/16 inch; link hanger, 18½ inches; eccentric throw, 2½ inches; rocker arms, top 13 inches, bottom 10 inches; main rod, 124 inches.

A valve motion model was rigged, full size, by which all events in the stroke could be noted by crank angles which were subsequently reduced for convenience of reading to inches of stroke of the piston to the nearest ⅛ inch. It had been customary to set these engines, having slide valves, with 1/16-inch lead in full gear, forward and back, and the model was first set in that way.

It was found that the lead at one-fourth cut-off (7½ inches) averaged ⅜ inch, and the distribution was very good. The full gear lead was then changed to line and line with a resulting 5/16-inch lead at one-fourth cut-off and slightly better distribution.

A third setting of 1/16-inch negative lead in full gear forward and back gave an average of ¼-inch at one-fourth cut-off and absolutely equal cut-off at each end. This might be construed by some who desire to equalize cut-off so as to allow for less on one side due to the effect of the piston rod as incorrect, but the results certainly show a fine motion.

A trial was then made of an unequal setting, giving line and line in full gear forward and ⅛-inch negative lead in full back gear. This had the effect of almost equalizing the lead over the range of one-half to one-fourth cut-off, but seriously disturbed the equality of cut-off, and the maximum port opening was no greater than in the previous setting.

The results of these tests are tabulated and presented herewith, the first line across in each setting being the forward stroke, the second the return, and so on, alternately. The offset of the link saddle pin was also tested and the results show that the fine equalization was largely due to this feature when the offset was 15/16 inch. A reduction of offset produced marked inequality with the only redeeming feature of a reduction of slip of the link block.

Analysis of link motion as above described is very interesting and the data secured will be found very valuable, particularly on roads whose custom is to have one fixed full gear lead for all engines, regardless of the length of blades, offset and other details of the motion. The small importance of full gear lead of itself is shown by the fact that to give 1/16-inch movement to the valve in full gear required a crank movement of but 1½ degrees, which is not perceptible in crank effect. Unless eccentric blades are long and full gear lead is necessary to give proper lead in running position of the link, it is absolutely detrimental.

As a matter of interest in connection with piston valves a

Effect of Changes in Full Gear Lead.

1/16 in. Lead in Full Gear Forward and Back.

Gear.	Lead.	Maximum Port Opening.	Port Closed.	Release.	Slip.
Full, forward.	1/16 in.	1⅝ in. in 3¼ in. piston travel.	26¼ in.	29 in.	1 7/16 in.
" "	1/16	1⅝ " 3 " " .	26	28¾	
" back....	1/16	1⅝ " 3⅝ " " .	26¼	29	1 3/16
" "	1/16	1⅝ " 3½ " " ,	26+	28⅞	
½ cut-off, Fd.	⅜	11/16 " 2¾ " " .	14¾	23¾	27/32
½ " " .	11/32	21/32 " 3 " " .	15¼	24	
¼ " " .	13/32	15/32 " ¾ " " .	7⅝	19	25/32
¼ " " .	11/32	13/32 " 1 " " .	7⅜	19⅜	

Lead Line and Line in Full Gear Forward and Back.

Gear.	Lead.	Maximum Port Opening.	Port Closed.	Release.	Slip.
Full, forward.	0	1⅝ in. in 3¼ in. piston travel.	26 in.	29 in.	Same slip in similar gears as above.
" "	0	1⅝ " 3½ " " .	26⅜	29	
" back....	0	1⅝ " 3⅛ " " .	26⅛	29⅛	
" "	0	1⅝ " 3⅞ " " .	26⅜	29	
½ cut-off, Fd.	9/32 in.	19/32+ " 3¼ " " .	14¾	24	
½ " " .	9/32−	19/32 " 3½ " " .	15¼	24¼	
¼ " " .	11/32	13/32 " ¾ " " .	7⅝−	19⅝	
¼ " " .	9/32	11/32 " ¾ " " .	7⅜+	20	

1/16 in. Negativo Lead in Full Gear, Forward and Back.

Gear.	Lead.	Maximum Port Opening.	Port Closed.	Release.	Slip.
Full, forward.	−1/16 in.	1⅝ in. in 3¾ in. piston travel.	26¼ in.	29⅛ in.	Same as above.
" "	−1/16	1⅝ " 3½ " " .	26½	29⅛	
" back....	−1/16	1⅝ " 4¼ " " .	26¾	29¼	
" "	−1/16	1⅝ " 4 " " .	26½	29¼	
½ cut-off, Fd.	7/32	9/16 " 3¼ " " .	14¾	24⅜	
½ " " .	3/16+	9/16 " 3¾ " " .	15¼	24½	
¼ " " .	¼+	11/32− " ¾ " " .	7½	20	
¼ " " .	¼−	9/32+ " ⅞ " " .	7½	20½	

Lead, Line and Line, Full Gear Forward, ⅛ in. Negative Full Back.

Gear.	Lead.	Maximum Port Opening.	Port Closed.	Release.	Slip.
Full, forward.	0	1⅝ in. in 3½ in piston travel.	26 in.	29 in.	
" "	0	1⅝ " 3⅛ " " .	26⅜	29	
" back....	−⅛ in.	1⅝ " 4½ " " .	26⅞	29¼	
" "	−⅛	1⅝ " 4⅛ " " .	26¾	29¼	
½ cut-off, Fd.	¼	9/16 " 3½ " " .	14½	24	
½ " " .	¼	⅝− " 4 " " .	15½	24½	
¼ " " .	¼+	5/16 " 1⅜ " " .	7	19⅝	
¼ " " .	¼+	5/16+ " ¾ " " .	8	20½	

Influence of Change in Off-set of Link Saddle Pin.

Lead $\frac{1}{16}$ in. Negative in Full Gear, Forward and Back.

	½ Cut-off.			¼ Cut-off.		
Off-set.	Port Closed.	Release.	Slip.	Port Closed.	Release.	Slip.
$\frac{15}{16}$ in.	14¾ in. 15¾	24⅜ in 24½	$\frac{27}{32}$ in.	7½ in. 7½	20 in. 20½	$\frac{25}{32}$ in.
$\frac{13}{16}$	14½ 15½	24⅛ 24½	$\frac{25}{32}$	7¼ 7¾	19¾ 20¾	$\frac{11}{16}$+
$\frac{11}{16}$	14¼ 15¾	24 24¾	$\frac{21}{32}$	7 8	19½ 21	$\frac{19}{32}$
$\frac{9}{16}$	13¾ 16¼	23⅞ 24¾	$\frac{17}{32}$	6¾ 8⅜	19¼ 21⅛	$\frac{15}{32}$
$\frac{7}{16}$	13½ 16½	23⅞ 24⅞	$\frac{15}{32}$	6⅝ 9	19 21⅜	⅜–

Port Opening Areas.

	Slide Valve.		Piston Valve.	
Lead in Full Gear.	Lead Opening.	Maximum Opening.	Lead Opening.	Maximum Opening.
	One half cut off.		One-half cut off.	
$\frac{1}{16}$ in. positive lead...	5¾ sq. in.	10¾ sq. in.	8.37 sq. in.	15 58 sq. in.
Line and line.........	4½ "	9½ "	6.5 "	13.75 "
$\frac{1}{16}$ in. negative lead ..	3¼ "	9 "	4.71 "	13.08 "
	One fourth cut-off.		One-fourth cut-off.	
$\frac{1}{16}$ in. positive lead...	6 sq. in.	7 sq. in.	8.72 sq. in.	10.17 sq. in.
Line and line....	5 "	6 "	7.26 "	8 72 "
$\frac{1}{16}$ in. negative lead..	4 "	5 "	5.81 "	7.3 "

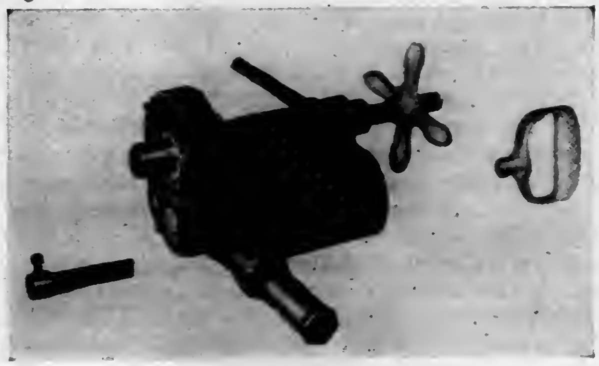
Note.—The above areas are calculated from a 16-in. steam port with slide valve and from a 10 in. piston valve deducting 8¼ in. for bridges.

table is presented giving the lead opening areas and the maximum port areas at one-half and one-fourth cut-off for the three settings above described, calculated for both slide and piston valves used with these engines. The advantage of the piston valve is readily seen, and when we consider that these openings will be maintained much longer by reason of less spring and wear of the piston valve motion, the argument would seem to be greatly in its favor.

NEW MONARCH PISTON AIR DRILL.

The accompanying engraving illustrates a pneumatic drill which is built with a solid tool-steel three-way crank, hardened at the various bearings and made ball-bearing throughout the drill. The pinions are made of tool steel. The piston-crank connections and end bearings of the crank are each provided with two sets of ball races. The engine part is entirely separate from the spindle. The makers claim this as a great advantage over other drills, on the ground that any undue strain put on the spindle cannot in any way affect the working part of the engine. The gears and pinions are also separate from the engine and are well protected against dust and dirt. The reversing throttle and starting throttle are all in one. In order to reverse the machine all that is necessary is to turn the throttle past the inlet ports and make connection with the ports that act as exhaust ports while the machine is running forward. This drill is also provided with a small lock, so that it can be made to run only in one direction when desired. This drill measures but 12 inches from the end of the spindle to the screw and it can be used within 2½ inches of a corner. Its weight is only 18 pounds and it will drill any size hole up to 1¾ inches in diameter. It has a feed-screw length of 4 inches. One of the most desirable features about this drill is that it is specially adapted for boiler work. It is reversible and can be used for tapping staybolts, running them in or out, and, in fact, can be used for any purpose where a reversible drill is desired. It is provided with a handle and standard ½-inch socket for machine bits, which will allow it to be readily converted into a wood-boring machine whenever desired.

The Standard Railway Equipment Company, makers of this



Monarch No. 4 Piston Air Drill.

new drill, claim economy in the consumption of air and simplicity in the mechanical construction. This drill will be furnished to any one desiring to give it a trial; also catalogues showing their Monarch tools may be had by addressing either the St. Louis, Chicago or New York offices.

LUCOL OIL AND PAINTS.

Lucol is an oil which has been used for painting purposes during the last ten years in various parts of the United States. It is prepared, like linseed oil, both boiled and raw, and it is especially suitable for painting and is held to be superior to linseed oil in many respects, but it has not yet been found adaptable to the manufacture of varnishes, for which large quantities of linseed oil are used.

It is a manufactured oil, built upon a base entirely different from linseed oil. Animal fats and oils consist of olein, margarine and stearine. The olein is extracted, and after being carefully refined is used as a base for the manufacture of lucol, which, when completely matured, is a brilliant transparent oil. The manufacturers state that the oil owes its "life" to the gum, which oxidizes out of it when mixed with pigments and used as a paint. This corresponds to the linseed-oil gum, but offers greater resistance to the destructive agencies in the air and to gases which may be present in the air. This material was developed on the Pacific Coast, the first factory being at Stege, Cal. It was subjected to very varying climatic conditions, such as those of Alaska, California, Arizona and the Hawaiian Islands. It is now manufactured at Carteret, N. J., and the development of the business and the demands for lucol have been rapid, especially during the recent period of depression.

The manufacture of lucol paint was commenced three years ago and it has already become necessary to enlarge the paint department a second time. While there is said to be no danger of spontaneous combustion with lucol, it has been deemed advisable to provide a fire-proof building of iron and concrete for the paint department, the object of this precaution being to insure against delays in supplying the demand.

The American Lucol Company manufactures paints for many different purposes. These include carbon, graphite, iron oxide, red lead and lead-zinc paints in all tints. The advantages claimed for these paints are good covering qualities, ability to retain glo. and original tints for a long time, good filling qualities for brick and wood, the absence of blistering, peeling and scaling, and elasticity, with high resistance to moisture, salt air and fumes of acids and chemicals.

There has been a controversy over the question of the best paint for the protection of iron work, and with the constantly increasing number of important metallic structures an adequate protection for their surfaces is correspondingly important. These manufacturers mix pure red lead with lucol for this purpose, making a pure red-lead paint and red-lead paste. This cannot be done satisfactorily with linseed oil, and many engineers and architects have been obliged to give up the use of red lead as a protective coating for iron for this reason.

The lucol red-lead paint has been named the "Red Dragon Brand." It is stated to be easily stirred up and made ready for use, to which is added the most important attribute of durability. Another paint, called "Telemet," is a carbon paint for structural iron, which is very elastic and durable. This concern manufactures the Lucol Spraying Paint, of which many railroad men speak in high terms. It is mentioned elsewhere in this issue in connection with the Columbus, Hocking Valley & Toledo Railroad. It is understood that but one coat of this spraying paint is required and that cars sprayed with it may be lettered on the same day, necessitating only about 12 hours' delay. Attempts have been made to produce such results by the use of dryers, but this seriously affects the durability of the paint.

In our August issue, 1898, page 259, we printed the test record of paints on the 155th Street steel viaduct in New York in which Mr. Henry B. Seaman places Lucol paint as second in a test of 17 paints for the most severe service imaginable.

The company is busy with its home trade, but the demand has already extended abroad, and we are informed that more than a car load of lucol paint was recently shipped to British India. There are probably no more conservative men to deal with in regard to paints than architects and engineers and steamship owners. Many of these have adopted this material exclusively, and this has been done as a result of tests made with linseed-oil paints. The Chief Engineer of the Brooklyn Bridge adopted this paint after a six years' trial of thirty barrels of lucol, which was compared in severe exposures with linseed oil and the same pigments. The train sheds of the Boston Southern Terminal and three of the four bridges across the Niagara River are painted with it. On one railroad where the first trials were made ten years ago, 25 car loads have been used for stations, bridges and cars during the last two years.

The American Lucol Company was organized ten years ago with a capital of $1,000,000, of which one-half is cash. The incorporators were those who fully understood the increased life of lucol over linseed oil, and the success of the company is due in a large measure to this fact.

PERSONALS.

Mr. C. N. Sanders has been appointed Chemist of the Norfolk & Western, vice Mr. W. W. Davis resigned.

Mr. Berian Warren, Master Mechanic and Purchasing Agent of the Toledo, Peoria & Western, has resigned and will retire from active railway service after a continuous and successful service of 48 years.

Mr. Charles Blackwell, who is well known to our readers, has been appointed Chief Engineer of the Wheeling & Lake Erie R. R. to succeed Mr. F. E. Bissell, who has resigned to accept service with another company.

Mr. Joseph Billingham, Master Mechanic of the Wheeling division of the Baltimore & Ohio, has been appointed Master Mechanic of the second, third, fourth and fifth divisions also, with headquarters at Cumberland.

Mr. Edward Grafstrom has resigned from his position with the Pennsylvania Lines at Columbus, Ohio, and has been appointed Mechanical Engineer of the Illinois Central Railroad, to succeed Mr. W. H. V. Rosing, promoted.

Mr. John T. Wheeler, formerly in the Purchasing Department of the Grand Rapids & Indiana, at Grand Rapids, Mich., has been appointed Purchasing Agent of the Sargent Company at Chicago, with office at 675 Old Colony Building.

Mr. M. E. Ingalls retired from the Presidency of the Chesapeake & Ohio on February 1, but continues as President of the Cleveland, Cincinnati, Chicago & St. Louis. He has been President of the Chesapeake & Ohio since October 1, 1888.

Mr. S. E. Dickerson has been appointed Master Mechanic of the Lake Shore & Michigan Southern at Norwalk, O., vice Mr. J. O. Braden, transferred. Mr. Dickerson was formerly in the mechanical department of the Norfolk & Western.

Mr. J. E. Battye has been appointed Division Master Mechanic of the Eastern General Division of the Norfolk & Western, vice Mr. R. P. C. Sanderson, who recently resigned, to become Assistant Superintendent of Machinery of the Atchison, Topeka & Santa Fe.

Mr. H. M. Pflager has been appointed Mechanical Superintendent of the Pullman Palace Car Co. He has been connected with this company for a number of years in various positions, of responsibility, and was promoted from that of Chief Mechanical Inspector.

Mr. R. F. Hoffman has been appointed Mechanical Engineer of the Atchison, Topeka & Santa Fe System, with headquarters at Topeka. He was connected with the editorial staff of the "Railway and Engineering Review" and two years ago he entered the services of the Santa Fe System. He has had a wide practical experience, having risen from apprenticeship.

Mr. Charles E. Morrill, who has been elected President of Valentine & Co., has been connected with that concern for nearly 40 years. He has had a prominent part in the development of the success of the company, and now takes the place of Mr. H. C. Valentine, who has retired from the presidency to become chairman of the board. Mr. Morrill will divide his time between the New York and Chicago offices.

Mr. Geo. W. Stevens, General Manager of the Chesapeake & Ohio, has been made President of that road, vice Mr. M. E. Ingalls, resigned. Mr. Stevens has been in railroad service since 1864, during which time he has been 6 years with the Baltimore & Ohio, 3 years with Pittsburg, Cincinnati & St. Louis, 17 years with the Wabash, working through several responsible positions to that of Assistant General Superintendent. He went to the Chesapeake & Ohio on January 1, 1890, as General Superintendent, and since July, 1891, has been General Manager.

Mr. E. D. Bronner, heretofore Assistant Superintendent of Motive Power and Equipment of the Michigan Central, has been appointed Superintendent of Motive Power and Equipment of that road, to succeed Mr. Robert Miller, resigned. Mr. Bronner entered the service of the Canada Southern in 1880 as draftsman in the car department. From February, 1883, to April, 1886, he was draftsman in the car shops of the Michigan Central at Detroit, and was then General Foreman of the same shops until 1890, when he was appointed Master Car Builder, which position he filled until May 1, 1896, when he was made Assistant Superintendent of Motive Power.

Mr. Robert Miller, Superintendent of Motive Power and Equipment of the Michigan Central and one of the best-known railroad men in the country, has tendered his resignation after a service of more than 35 years. Mr. Miller's career dates from 1859, and is as follows: From 1859 to 1862, journeyman in the car shops of the Chicago, Burlington & Quincy; 1862 to 1865, in the army; 1865 to 1876, Foreman erecting shops, Chicago, Burlington & Quincy; 1876 to 1884, Master Car Builder, in charge of cars and buildings and water-works, Michigan Central; 1884 to 1890, Assistant General Superintendent of the same road. In 1890 he was made General Superintendent, which position he held until 1896, when he was made Superintendent of Motive Power and Equipment.

Mr. R. P. C. Sanderson, Master Mechanic of the Norfolk & Western, has been appointed Assistant Superintendent of Ma-

chinery of the Atchinson Topeka & Sante Fe, vice Mr. G. A. Hancock resigned. He will make his headquarters at Topeka, and will have more extensive authority than that vested with Mr. Hancock. Mr. Sanderson began railway service in 1882 as draftsman on the Norfolk & Western, and has worked his way up through many responsible positions. In 1891 he was appointed Superintendent of Motive Power of the western general division of the same road. In February, 1895, he was placed in charge of maintenance of locomotives and cars for the entire line and later was made Master Mechanic at Roanoke, which position he has filled up to the time of his new appointment.

Dr. James H. Smart, President of Purdue University at Lafayette, Ind., died February 21. He had been President of the University since 1883. He was born at Center Harbor, N. H., June 30, 1841. He held a degree of A. M. from Dartmouth and LL. D. from the University of Indiana. He attended the Vienna Exposition in 1872 as Assistant Commissioner from Indiana and was United States Commissioner to Paris Exposition in 1878. At the Agricultural Congress at The Hague in 1891 he represented the United States as a Commissioner from the Department of Agriculture. He was elected President of the Indiana Teachers' Association in 1871, and in 1880 held a similar office in the National Educational Association; was also President of the American Association of Agricultural Colleges and Experiment Stations in 1890. His life work was the development of Purdue University, which is a magnificent monument to his ability, energy and self-forgetfulness.

Edwin N. Lewis, Manager of the Railway List Company of Chicago, died at his home in Chicago, February 16, of heart trouble after a brief illness. He was an unusually interesting man, a warm and valued friend to those who had the privilege of knowing him well and he will be missed also by a very large number who enjoyed his acquaintance. Those who met him occasionally found pleasure and profit in his company, because he commanded a large amount of information and was always ready to contribute it in a delightful way. He was earnest, sincere and honest. He had a very convincing way of presenting his arguments, he was a hard worker and stood in closer and more intimate friendly relations with business men than any other man in his line of work. Mr. Lewis was born in Madison County, New York, September 12, 1837. He was educated in Fowler Institute, Newark, Illinois; Knox College, Galesburg, Illinois; Beloit College, Beloit, Wis., and Chicago Theological Seminary, Chicago. After completing his education he was a Congregational pastor and afterward studied law in the office of Cook & Glover. Mr. Cook, of this firm, was later general solicitor of the Chicago Northwestern Ry. and Mr. Lewis succeeded to his practice, which drifted into railroad litigation and especially right of way work. After this he took up newspaper writing on the staff of the "Railway Age," and was instrumental in the success of the Railway Exposition of 1883. He became Manager of the "Railway Purchasing Agent" in 1885 and remained with this publication (which changed its name in 1886 to the "Railway Master Mechanic"), also Manager of the "Official Railway List" up to the time of his death. He read a great deal and was a clear and forcible writer.

BOOKS AND PAMPHLETS.

Master Car and Locomotive Painters' Association. Proceedings of the 30th Annual Convention. Held at Philadelphia September, 1899. Published for the Association by the Railroad Car Journal, New York, 1899.

This volume contains the official proceedings of the recent convention, the constitution, rules and names of members with their positions and addresses. It is well printed and bound.

"The Contractor." The first number of this publication has appeared. It is a fortnightly review of work in the field of construction, dredging, bridge building and engineering operations and contains information concerning proposed work of these kinds. It is not confined to any special line of construction, but railroad work predominates. In the railroad items the length of the proposed lines is given first, which is one of the minor features which helps the reader. It is edited by Walter D. Crosman, and published by the Crandall & Bagnall Publishing Co., 1305 Manhattan Building, Chicago.

"Round the World by Way of New York and Niagara Falls in Sixty to Eighty Days," is the title of a large and handsome folder and railroad map of the United States issued as No. 21 of the Four Track Series by the New York Central & Hudson River R. R. It will be sent on receipt of three cents in stamps by George H. Daniels, General Passenger Agent, Grand Central Station, N. Y.

A pamphlet illustrating and briefly describing a new line of air compressors has just been issued by the New York Air Compressor Company, with works recently established at Arlington, N. J., for the manufacture of simple and duplex direct steam driven or belt driven compressors to meet all requirements of users of pneumatic power. These compressors have been designed with special reference to simplicity, economical service and utmost durability in working parts and absolutely self controlling features. The pamphlet also gives a detailed description of their vertical belt air compressors and gas or gasoline actuated air compressors, which are specialties of these builders.

Ten years ago a technically educated young man did not have the high standing among practical men that now enjoys. He is sought after to-day. The increased demand for men who can operate our mechanisms with less loss than before and effect savings in dollars and cents are the men the large manufacturing and engineering concerns are looking for, and these are the men with a technical foundation. This increasing demand is very interestingly shown by the new catalogue of the Massachusetts Institute of Technology, which is a volume of 360 pages, of which nearly one-third are occupied by the register of graduates and their professional occupations. Also the effect of the growth of the institute in numbers and the very rapid growth in the number of responsible positions in which each years graduates are found is exceedingly interesting. The catalogue also gives the character and quality of the work of the Institute, which is of a high character and worthy of commendation.

Machine Tools.—A very neat catalogue of machine tools has just been issued by the Hilles & Jones Company, Wilmington, Del. This catalogue, No. 6, is 9 inches square, bound in cloth, with 135 pages of illustrations. Those who are familiar with the No. 5 catalogue of this company, which was issued in 1893, will note many changes in their standard patterns which were found necessary in order to meet the continued demand for heavier and more effective machinery. Among the tools of very large capacity which are illustrated and very briefly described in this catalogue are punches and shears, I beams and channel coping and notching machines, plate bending and flanging rolls, vertical milling machines and other standard machines and tools. The illustrations and press work are of a very high order. The descriptions are clear and concise.

Automatic Machinery Catalogue.—The Spencer Automatic Machine Screw Co., of Hartford, Conn., have issued an excellent illustrated catalogue of their automatic machines and the work which may be done upon them. The machines are built in three sizes and in two styles, double and single turret. With these sizes and styles a great variety of work is provided for and the name of the concern, carrying with it the standing gained by twenty years of experience in the field, renders it entirely unnecessary to speak of the qualities of design and workmanship. With the double turret machines work may be done upon both ends of a piece at the same time, and the operations may be carried on as quickly as one. Special provision has been made to secure the turrets rigidly for the sake of accuracy. Six very fine engravings of the machines are shown, and upon the pages facing them are the characteristics of each given in English and metric measures. In other engravings the tools employed and illustrations of the work done by the machines are shown, full size. The pamphlet contains directions for arranging the machines upon the floor to the best

advantage and also the best method of belting to the counter shaft. This is commended as an excellent catalogue. It gives all necessary information about the machines in a few words, and the engravings are selected and executed with noteworthy skill of which the interesting and valuable machine is thoroughly worthy. Our readers who have not investigated these machines should lose no time in doing so, particularly for the small iron and brass work of which the large railroads have a great deal. They are specially adapted to the manufacture of screws, set screws and studs.

"The School of Mechanical Engineering." The International Correspondence Schools of Scranton, Pa., have issued a pamphlet bearing this title. It contains information with regard to the courses of the school in mechanical engineering, mechanical drawing, gas engines, refrigeration and machinery, and will give the information concerning the schools which is desired by those who are considering taking up this form of education.

A New Industrial Situation.—This is the title of a very attractive pamphlet received from the Westinghouse Companies, presenting what is truly a new situation brought about by the introduction of the gas engine into the electric lighting and railway fields. It has an introduction by Mr. Geo. Westinghouse, calling attention to the present wide interest and recent improvements in the generation and distribution of power. He says that long familiarity with the electrical industry, the pipe line transportation of natural gas in great quantities, and an active interest in the development of large gas engines, satisfy him that the economies which will result from the distribution of power by means of gas generated at central points, and conveyed in pipes along the lines of railway, for the operation of engines and electric generators, will be sufficient to justify the expenditure of the capital necessary for such installations in connection with the electrical equipment of railways, particularly metropolitan and suburban lines. The Westinghouse Companies have brought to a high state of perfection all the requisite machinery for the commercially successful operation of standard railways upon which trains are frequent. Mr. Westinghouse states that the advantages of the use of gas engines can be best appreciated when it is understood that if a gas company were to supplant the present gas illumination by an equal amount of electric light, obtained from gas driven dynamos, it would have left for sale, for other purposes, over 60 per cent. of its present gas output. The pamphlet gives the place of the gas engine in the new industrial situation, which in its present development, offers a regulation of speed and smoothness of working equal to the best steam engine on the market. It has been demonstrated that engines of large power up to 650 horse-power are entirely successful and at present two 1,500 horse-power engines are under construction. The pamphlet hints at methods for producing gas at an extraordinarily low cost, as being an expectation of the near future. This statement is made after long and carefully conducted experiments, which the Westinghouse people consider justifies the belief that within a short time gas will be produced commercially and sold at a cost far below the lowest price that now prevails in any part of the world. This expectation realized will constitute a new industrial situation, the full meaning of which cannot now be realized, and the accomplishments of the Westinghouse Companies have been such as to justify faith in the prediction as not being too sanguine. Given cheaper gas, the gas engine at once will take a foremost place. The pamphlet includes a number of engravings of Westinghouse gas engines, applied to lighting and power production and describes a number of successful examples. On reading this pamphlet, the conclusion is forced that there is a great deal back of it, because, as stated in the opening paragraph, "Engineers the world over have long recognized the fact that gas, if supplied at a practical cost, conveyed economically over long distances, and utilized in a form of engine, which should, in speed regulation and smoothness of working, equal the best steam engine, would be the ideal fuel." When such a man as Mr. Westinghouse makes a promise of this kind, fulfilment may be expected.

EQUIPMENT AND MANUFACTURING NOTES.

The Gilman-Brown emergency knuckle, which we illustrated last year, is making satisfactory progress. This device is used in emergency repairs to replace coupler knuckles of various makes and is carried in the cabooses of freight trains. Its form permits of using it temporarily in place of the knuckle of almost any of the couplers now in use. It is manufactured and sold by the Railway Appliance Co., Old Colony Building, Chicago. Five hundred have recently been supplied to the Northern Pacific.

The Cling-Surface Manufacturing Co., of Buffalo, N. Y., has been incorporated under the laws of the State of New York, retaining its former name, with Albert B. Young as president and general manager and William D. Young, vice-president and secretary. The company states that the past year has been the most prosperous in its history, and that the demand for "Cling Surface" is steadily increasing. Branches have been established in Boston, New York and Chicago, while others will be opened soon in St. Louis and New Orleans. W. J. Moxham & Co. importers, Sidney, Australia, have placed a large order and will have the exclusive right to handle it in Australia.

The American Machinery & Trading Co., with chief office in the Bowling Green Building, New York, is prepared to furnish at most favorable prices all lines of high-class factory, mill, electric and power plant machinery, and invites plans and specifications giving date of required delivery. This company will accept agencies from manufacturers for the sale of first-class machinery in foreign countries. An idea of the scope of the concern is given by the following list of branch offices: Chicago, Boston, Philadelphia, Pittsburg, Atlanta, St. Louis, San Francisco, Montreal, London, Paris, Berlin, St. Petersburg and Sydney.

A patent was recently granted Mr. C. W. Sherburne, of the Automatic Track-Sanding Company of Boston, for a new port in the Westinghouse engineer's brake valve, which may be connected at a trifling expense to the air track sanding apparatus, of any manufacture, on the locomotive, thereby insuring automatic flowing of the sand when emergency application is made. This is a specially desirable feature, as all brake experts testify that every part of the brake equipment should be applied by one motion only. This style of engine valve will be furnished by the Westinghouse Air Brake Company when requested.

The Rhode Island Locomotive Works have received orders for 5 consolidation and 3 ten-wheel passenger locomotives for the Colorado & Southern Ry. and for 5 ten-wheel passenger engines for the Fort Worth & Denver City Railroad. The 5 consolidation engines will have cylinders 21 by 28 inches, driving wheels 56 inches in diameter, they will weigh 166,000 pounds, with 148,000 pounds on the driving wheels. The boilers will be of the straight top type with radial stay fireboxes and will carry a working pressure of 190 pounds. The tubes will be 13 feet 6 inches long and 2 inches diameter; the firebox will be 114 by 41¼ inches. The capacity of the tank for water will be 5,500 gallons and the coal capacity 10 tons. These engines will have staybolts of Ulster special staybolt iron, main driving boxes of cast steel, Latrobe tires, Monitor injectors, Nathan lubricators, Standard couplers, magnesia sectional lagging, the Leach sanding device and Sargent combination brakeshoes. The ten-wheel passenger engines for the Colorado & Southern will have cylinders 20 by 26 inches, driving wheels 63 inches in diameter; they will weigh 152,000 pounds, with 118,000 pounds on the drivers. The boiler will be of the extended wagon top type with radial stays, carrying a working pressure of 200 pounds. The tubes will be 13 feet 4 inches long and 2 inches diameter. The firebox 120 by 42 inches. The tank capacity for water will be 5,500 gallons and the coal capacity 10 tons. These engines will have Ulster special staybolts, cast steel driving wheel centers, cast steel main driving boxes, Latrobe tires, Monitor injectors, Nathan lubricators, Magnesia sectional lagging, Leach's sanders and Sargent combination brakeshoes. The 5 ten-wheel passenger locomotives for the Forth Worth & Denver City will have 20 by 26-inch cylinders, 63-inch driving wheels, and will weigh the same as the engines of the same type for the Colorado & Southern. The special equipment and general features of the design of the ten-wheelers for both roads will be practically the same.

CHIEF CLERK WANTED.

Motive Power Department.

A good chief clerk is wanted for the motive power department of a large road in the Middle West, salary $1,800 per year. Executive ability and familiarity with locomotive and car matters are required. Address the Editor of the American Engineer and Railroad Journal.

AMERICAN
ENGINEER
AND
RAILROAD JOURNAL.

APRIL, 1900.

CONTENTS.

LOCOMOTIVE DESIGN.

By F. J. Cole, Mechanical Engineer Rogers Locomotive Works.

Equalization of Weights.

(Concluded from page 70.)

The mogul type of engine has a two wheeled radial truck in front and three pairs of coupled driving wheels. The spring arrangement is shown in Fig. 7. There are three points of support, one at B, the fulcrum of the truck equalizer, and two at A (one on each side) the fulcrums of the equalizing levers between the main and back wheels. The back end of the front driving spring is fastened to the frame, while the front end is connected by means of a cross beam to the truck equalizer. In Fig. 7 the longitudinal center of gravity of the engine above the springs is located 63 inches ahead of the equalizing lever fulcrum of the main and back wheels. This is determined as follows: From the weights of each pair of wheels resting on the rails, is deducted the weight of the wheels and axles with the parts carried directly by them, such as eccentrics, eccentric straps, part of the eccentric rods, driving boxes, back end of main rod, etc. This leaves a net load of 24,000 pounds on each pair of driving springs or 48,000 pounds for the two rear pairs of wheels. One-quarter of this or 12,000 pounds is carried by each pair of front and back spring hangers of the back and main driving springs, and one-half or 24,000 pounds is carried by the equalizer fulcrums at AA. The common center of gravity of the combined weights carried by the main and back wheels is also at AA, midway between the wheels. It is evident that the weights on each of these wheels are the same because the springs are connected by levers with equal arms. A weight of 12,000 pounds is carried by the forward ends of the front driving springs and 11,000 pounds by the truck. The proper location of the fulcrum, B, to give the respective weights on either ends of the truck equalizer, may be found by multiplying the total length of the lever by the weight on the truck and dividing this product by the sum of both the loads; the quotient will be the length of the back portion. Thus

$$\frac{11,000 \times 78}{23,000} = 37.$$

The common center of gravity of the load on the truck

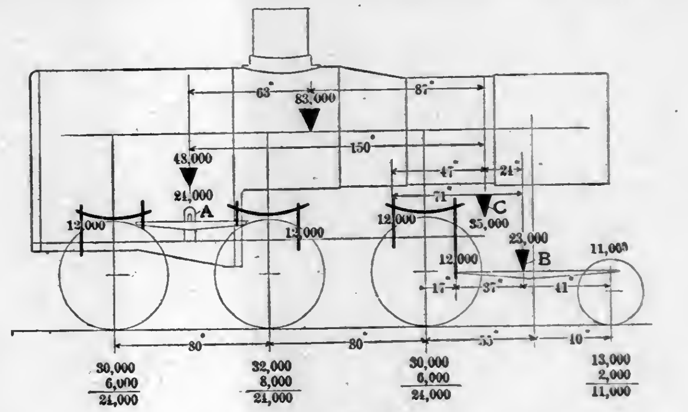


Fig. 7

Wheel Loads and Arrangement of Equalizers for Mogul Engines. The weights given are for both sides. For one wheel take one-half the load.

equalizer at B and that on the back hanger of the front spring, 23,000 and 12,000 pounds respectively, is found in a similar manner to be at C, 47 inches from the back hanger or 30 inches from the center of the front driver. The two centers, A and C, which are 150 inches apart, may now be combined. The rear one, A, equals a load of 48,000 pounds and the front one, C, 35,000 pounds, making a total of 83,000 pounds. The common center of gravity is found to be 63 inches from the fulcrum A. To obtain equal weights upon each wheel with the wheel base and weight on the truck as given in Fig. 7, the center of gravity must be located in the position shown. If this is not done no amount of subsequent adjustment of the equalizing levers will produce a uniform distribution of weight upon all the drivers and give the proper proportion upon the truck. Considerable variation of weight upon the truck may be effected by changing the position of the lever fulcrum, B, but this only serves to change the relation existing between the front wheel and the truck, which does not materially affect the other two pairs. It follows then, that if the sum of the loads on the truck and front wheels are not sufficient the deficiency can not be made up in any other way than by altering the

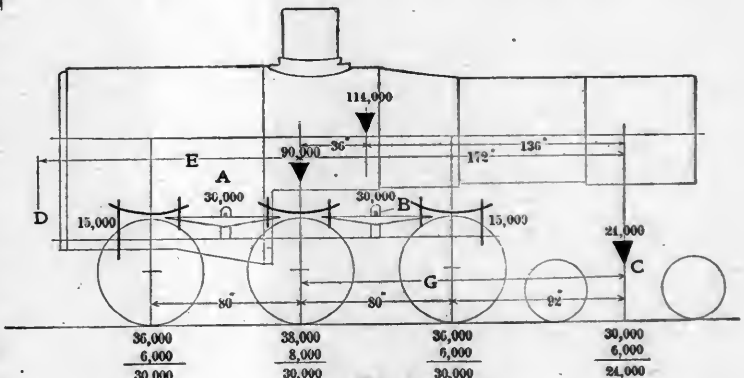


Fig. 8

Wheel Loads and Arrangement of Equalizers for 10-Wheel Engines. The weights given are for both sides. For one wheel take one-half the load.

position of the center of gravity of the entire superstructure, either by shifting its position bodily or by a readjustment of some of the heavy parts. It will be readily observed that within the limits of the ordinary designs of mogul engines the weights carried by the main and back wheels are equal, as the springs are connected by equalizing levers with similar arms.

For a predetermined truck weight the weights carried by the front driving wheels will only equal those of the main and back, when the position of the boiler and its attachments, etc., is so located as to bring the center of gravity in the correct

position. When the firebox is between the main and rear axle the average weight is 17 per cent. on the truck and 83 per cent. on the drivers, and with a long firebox extending over the rear axle, 14 per cent. on the truck and 86 per cent. on the drivers.

The spring rigging arrangement of a 10-wheel engine is shown in Fig. 8. In this type there is a 4-wheel truck in front and three pairs of coupled driving wheels. The three driving wheel springs on each side are connected together by two equalizing levers so that the weight supported by each pair of wheels is the same, irrespective of the overhang of the firebox, or excessive weight of the back end. In this type, as in the 8-wheel type, there are three fixed points in the equalizer

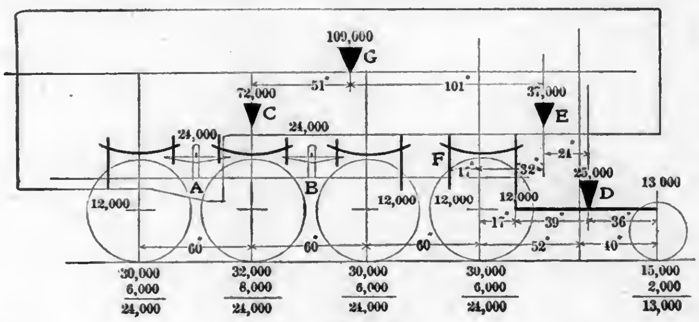


Fig. 9

Wheel Loads and Arrangement of Equalizers for Consolidation Engines.

The weights given are for both sides. For one wheel take one-half the load.

system, the truck center C and two centers of equalizers, although the frames are supported at four points or fulcrums instead of two as in Fig. 7.

When the firebox is between the main and rear axles the average weight is 26 per cent. on the truck and 74 per cent. on the drivers. When the firebox extends over the rear axle the average weight is about 22 per cent. on the truck and 78 per cent. on the driving wheels. The effect of changes in weight in the simplest form may be considered by supposing an increase of weight of 1,000 pounds at D. The increase on the drivers will equal $\frac{1,000 \times (E + G)}{G + (\frac{1}{2} F)}$.

The decrease on the truck will equal $\frac{1,000 \times E}{G}$.

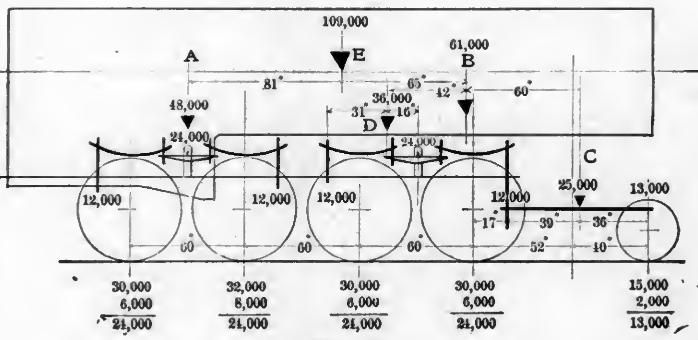


Fig. 10

The consolidation type of locomotive has a 2-wheeled radial truck in front and four pairs of driving wheels. The ordinary form of spring arrangement is shown in Fig. 9. Three pairs of driving wheels, the second, third and fourth, are equalized together, therefore, the loads carried by these wheels are the same. The equalizer lever fulcrums are at A and B, each of them carry 12,000 pounds or 24,000 pounds for both sides, as shown in the diagram. As these three pairs of driving wheels are spaced an equal distance apart, the center of gravity of the sum of the weights on these drivers will be located midway or over the center of the main wheels at C.

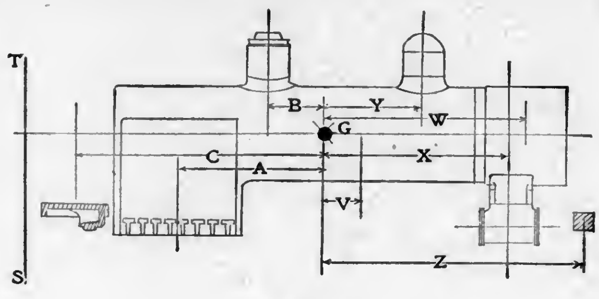


Fig. 11

The center of the truck fulcrum is at D, 39 inches from the front spring hanger or 56 inches from the center of the front wheel; the sum of the weight on the truck and that of the front hanger of the front spring, 13,000 + 12,000 = 25,000 pounds, is carried at this point. The common center of gravity of the weights at D and F, 25,000 + 12,000 = 37,000 pounds, is located at E, 49 inches from F, or 32 inches in front of the forward wheel.

The common center of gravity of the weights at C and E, 72,000 + 37,000 = 109,000 pounds, is located at G, 51 inches ahead of the main axle. When this arrangement of equalizers is used, the extreme range is 51 inches from the position G, where the weight is equally distributed on all the drivers with a suitable ratio on the truck, to position C, where all the weight would be carried on the three rear pairs of wheels, and none on the front pair of drivers and on the truck. The range ahead from G to E is 101 inches. At position E all the weight would be carried on the front pair of driving wheels and on the truck and none on the three back pairs of driving wheels.

The arrangement of equalizers shown in Fig. 10 is often used for consolidation engines which are too heavy behind. The springs on the main and rear driving wheels are con-

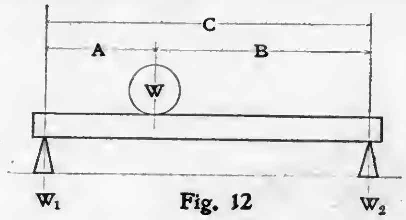


Fig. 12

nected by equalizing levers. The fulcrum is at A and the center of gravity of the weight (48,000 pounds) carried by these two pairs of wheels is at the same point. The forward center of gravity of the weights on the truck and the two front pairs of drivers (61,000 pounds) is at B, 60 inches back from the truck fulcrum, C. The common center of gravity of the combined weight at A and B is located at E, 81 inches ahead of A or 51 inches ahead of the main wheel. This is the same position as shown in Fig. 9, therefore to get an exactly equal distribution of weight on all the driving wheels and the same ratio on the truck, the center of gravity must be the same, irrespective of the arrangement of equalizing levers, provided they have arms of the same length.

The advantage of this arrangement in Fig. 10 consists in the fact that the range is 81 inches backward before the entire load would be carried on the two rear pairs of driving wheels and none on the front pairs and on the truck, whereas in Fig. 9 the range was only 51 inches. Therefore, for narrow gauge engines with fireboxes behind the rear axles and for other consolidation engines of ordinary builds which are too heavy behind, there is some advantage in this plan.

With one axle under the firebox the average weight is 11 per cent. on the truck and 89 per cent. on the driving wheels. With two axles under the firebox the average weight is 14 per cent. on the truck and 86 per cent. on the driving wheels.

Often the weight on one pair of wheels is the limiting factor in the design of a new locomotive. The size and power of

the engine must then be made to conform to some maximum wheel load. In order to obtain the greatest efficiency consistent with this limitation, the weights on all the driving wheels should be made as nearly alike as possible. It is, therefore, desirable in such cases where all the driving wheel springs are not connected by equalizing levers to locate the center of gravity of the superstructure carried by the springs, so that all the driving wheel loads will be the same. Then proceed to locate the boiler and other heavy parts in such positions as will produce the desired results.

To ascertain whether an engine balances at G, the theoretical center of gravity, Fig. 11, the weight of each part and its distance from G must be known. The boiler should be divided into convenient sections whose centers of gravity can be easily found. For instance the back end, including the firebox, grates, etc., naturally group themselves together at A. The cylindrical part, including the flues, makes another group at Y, and the smokebox a third part at W. Multiply the weight of each group or part by the distance of its center in inches from G, and put down the results for either right or left hand in separate columns. If the totals are the same the distribution is correct. If the totals are unequal, take the difference between the amounts and divide by the total weight, the quotient will be the distance in inches of the actual center of gravity to the front or rear of G. Example:

Left.		Right.	
C = 150 × 400 =	600,000	W = 130 × 2,000 =	260,000
A = 100 × 18,000 =	1,800,000	V = 24 × 15,000 =	360,000
B = 20 × 2,000 =	40,000	X = 125 × 12,000 =	1,500,000
		Y = 50 × 150 =	75,000
24,000	2,440,000	Z = 150 × 1,000 =	150,000
		31,500	2,345,000

The difference between the totals is 95,000. The total weight is 24,000 + 31,500 or 55,500 pounds $\frac{95,000}{55,000} = 1.71$ inches. Therefore, the actual center of gravity is 1.71 inches ahead of G the theoretical. In order to exactly equalize the weights, an amount must be added or taken from either side whose weight multiplied by its distance in inches equals 95,000, or the position and weight of some of the parts must be readjusted.

To obtain the center of gravity of the weights for either side divide the total product by the sum of the weights for that side. Then for the weights and distance given in Fig. 11

$$G_R = \frac{2,440,000}{24,000} = 101.6 \text{ inches.}$$

$$G_L = \frac{2,345,000}{31,500} = 74.4 \text{ inches.}$$

Another way to find the center of gravity of a number of weights is to measure the distance of each from some fixed point outside the group (as for example the vertical line, ST, Fig. 11). Then multiply the weight of each part or group by its distance from the line ST. Add the results thus found for all the weights together and divide by the total weight of all the parts, the quotient is the distance of the common center of gravity from the line ST.

In Fig. 12

$$A = \frac{W_2 C}{W} \qquad B = \frac{W_1 C}{W}$$

$$W_2 = \frac{AW}{C} \qquad W_1 = \frac{BW}{C}$$

The above formulas will be found useful in determining the proper position of equalizing lever fulcrums, when the arms are made of an unequal length in order to carry more weight on one end than the other. Also to locate the truck equalizer fulcrums of mogul or consolidation engines.

EDITORIAL CORRESPONDENCE.

Buffalo, Rochester & Pittsburgh Railroad.

The shops of this road at Rochester are not modern, and they will soon be replaced by a suitable plant in which the best facilities will be provided. The amount of work turned out is very creditable to Mr. C. E. Turner, Superintendent of Motive Power and his assistants.

The piston valve as applied to a number of engines by the Brooks Locomotive Works has earned a high place here, and it is doubtful whether the slide valve will be used on future orders. Mr. Turner is decidedly pleased with the central admission feature and believes that the protection of the passage for the entering steam from radiation by being placed between the exhaust steam passages is a very valuable improvement. He made a point of the fact that this arrangement necessitated crooked exhaust passages and consequently larger ones than would be needed if they were as straight as in the case of slide valves. This is provided for in the Brooks design by a slight extension of the ends of valve casings to give room for larger passages at the ends. There is no objection to this, and it seems to overcome a little of the back pressure which, however, has not been excessive with this form of valves. The crooked passage needs to be made larger than the straighter one. The location of these valves in the saddles instead of upon the tops of the cylinders makes it easy to protect them from radiation, and in these engines the saddles are lagged to a higher point than has been accomplished before.

Mr. Turner has given a great deal of attention to the design of cars of large capacity to adapt them to the special conditions of the coal, coke, and ore traffic of the road. On looking over the drawings, it was seen that the castings, which were all of malleable, iron are remarkably light, and where possible the fiber stresses were kept down to 4,000 lbs. per square inch. This was determined upon after tests of the material showing it to be safe to count upon an elastic limit of 30,000 lbs. and ultimate strength of 40,000 lbs. In spite of the low allowable working stress of but 4,000 lbs. the castings generally weighed so much less than cast iron that notwithstanding the advantage of 43 per cent. difference in price in favor of cast iron at the time of the design the cost of the malleable was less than that of cast iron. The total weight of malleable castings in cars of 80,000 lbs. capacity in spite of the additional castings required in the heavy bolsters of the large cars, is less than that of the cast iron formerly used in cars of 40,000 lbs. capacity. A characteristic of Mr. Turner's car designs is the use of deep trusses. In one case he has brought the truss rods to within 10 inches of the rail, the truss being 27½ inches deep.

Mr. Turner has for some years used a convenient form of jig for laying off car timbers of all kinds. These are cut to the desired shape and upon side they carry pointed plungers in tubes supported over holes in the jig. These plungers may be struck through the holes by hand to mark the centers of bolt holes and mortises. Each plunger is marked with the size of the hole. This greatly reduces the labor of marking out the timbers. A number of convenient air tools have been developed here, among which is Mr. Turner's flue cutter and roller, which is now well known. It has recently been fitted with an ingenious governor which automatically reduces the speed of the motor, and saves air when it is not actually rolling or cutting.

Chicago, Burlington & Quincy.

A good suggestion was received during a call upon the Superintendent of Motive Power of this road. He prepares an annual report covering the important work of the year, to enable him to keep track of the work of the department, the condition of its equipment, and to afford a review of progress that has been made. This fixes dates of important changes and improvements, and it appears to be an excellent plan. The idea was a new one to our correspondent. Its chief recommendation seems to be that it brings up the work of a year in condensed form and is suggestive of the lines which have proven advantageous in the past and which will probably pay to follow in the future. It must necessarily take considerable thought, and if a man analyzes his own work in order to set forth that which has been most valuable he will probably see ways in which to improve it.

The cost of doing work is considered as most important information on this road. Recently the entire cost of building locomotives has been thoroughly investigated and the information tabulated with great care and thoroughness. The lack of exact knowledge as to the shop costs of work on railroads is noticeable, and very few foremen have the slightest idea of the cost of various shop operations. Under present conditions this information is invaluable, particularly in connection with the introduction of new machinery. A man who knows what his work now costs and how much he can save by a new machine, has a strong argument with the management when he asks for appropriations for new machines.

The appointment of an inspector of oiling has proved a paying investment on this road. A reduction of the cost of oil for cars and locomotives amounting to over $2,000 in three months was secured, and at the same time there was a large reduction in the number of hot boxes and in the amount of waste used. There was a small increase in the number of brasses used, but brasses have a scrap value to offset this. The use of more brasses is due to an attempt to lead the inspectors to understand that a hot box needs attention, and usually something more than oil is required to prevent it from heating again. The pursuit of the hot-box problem on this road is persistent and systematic. The results indicate that a large amount of the trouble may be easily overcome.

Fig. 1.—80,000 Pounds Capacity Steel Frame Coal Car—Norfolk & Western Railway—With Test Load.

W. H. Lewis, *Superintendent Motive Power.* C. A. Seley, *Mechanical Engineer.*

80,000-POUND STEEL-FRAME COAL CARS WITH DROP DOORS.

Norfolk & Western Railway.

Frames of Structural Steel With Wooden Floors and Siding.

This road has in service the larger part of a lot of one thousand 100,000-pounds capacity copper-bottom coal cars, with steel under frames and wooden hoppers, the design of which was illustrated and described in the June, 1899, issue of this journal. Through the courtesy of Mr. W. H. Lewis, Superintendent of Motive Power, and Mr. C. A. Seley, Mechanical Engineer of the road, we have received drawings and information concerning a new design of a somewhat different type of car, from which this description is prepared. The chief dimensions of the car are as follows:

General Dimensions.

Length, over buffer blocks	36 ft. 6½ in.
Length, over end sills	35 ft. 1 in.
Length, inside of box	33 ft. 0 in.
Width, over side sills	9 ft. 1 in.
Width, inside of box	8 ft. 9½ in.
Height, inside of box	4 ft. 6 in.

In the present design, as will be seen from Figs. 3 and 4, advantage has been taken of the opportunity afforded by the box of the car having full sides of considerable height, to introduce a truss to support the sides, thereby using very light side sills and dispensing with the stakes ordinarily used. The small light weight of the car is largely due to this feature of the design.

The truss members are 5-inch channels of the necessary weight required by the loads at the various panels. The bottom chord or side sill is an 8-inch 11½-pound channel, the top chord is a heavy angle, and ½-inch by 6-inch gusset plates are also used for the upper connections. The angle also serves as a coping for the wooden lining of the car.

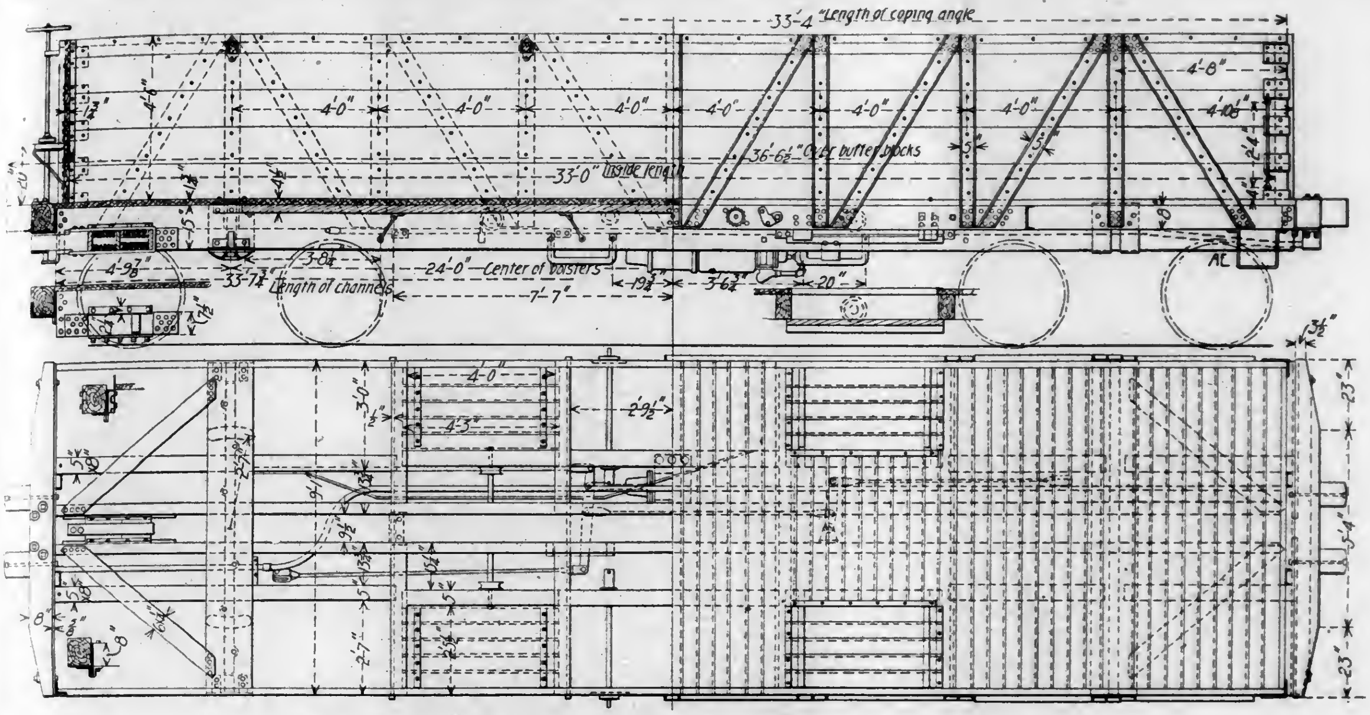
The center sills are 15-inch, 33-pound channels, secured to the end sill plates and body bolster members by angle irons, and it will be noted that the full strength of the flanges has been preserved by making all holes for connections through the webs of the channels. The body bolsters are located 4 feet 10 inches from the outside ends of the sills and are designed with steel plates and malleable-iron fittings, riveted up in such a manner as to secure the necessary rigidity.

All of the material used in the construction of the car is in the form of standard rolled sections or regular sizes of bars or plates, no special or unusual sizes being employed. All attachments, such as drop-door hinges, cross-sill supports and brake fixtures, are riveted on. In order to provide door pockets and immediate floor support, a system of short wooden intermediate and cross sills, 5 by 8 inches, are used as shown in the plan view of the car, Fig. 2. These sills are grooved for 1 inch through tie rods.

The lining of the car is of 1¾-inch pine, and the floor, of which there is an area of 287 square feet, is of the same material, 1¾ inches thick by 6 inches wide, and ship lapped. Owing to the height of the sides of the box of the car and the lateral pressure of coal as lading, four 1½-inch top cross tie rods are used to prevent bulging. These, however, will not prevent using the car for lumber. Four drop doors, 48 by 27¾ inches, are provided, which are handled by winding shafts, chains, ratchets and locks, similar to those generally used in such equipment. The doors are so located as to dump a large proportion of the contents of the car when dumping is desirable. The car is equipped with Westinghouse air brakes, the design of the underframing permitting a very simple direct brake system. The couplers are arranged with tandem springs and the draft lugs are riveted direct to the center sills.

This car was designed to take a lading of 88,000 pounds and not to exceed 10,000 pounds fiber strain in its members. The test load of the sample car was wet coal, and when well heaped up weighed 92,700 pounds. This was subsequently increased by heavy rains to 95,250 pounds. Under this load the deflection of the center sills was ¼ inch, and that of the sides was not quite ⅛ inch.

The car, as shown in Fig. 1, is mounted on a pair of diamond



80,000 Pounds Capacity Steel Frame Coal Car—N. & W. Railway.
Fig. 2.—Plan and Longitudinal Section.

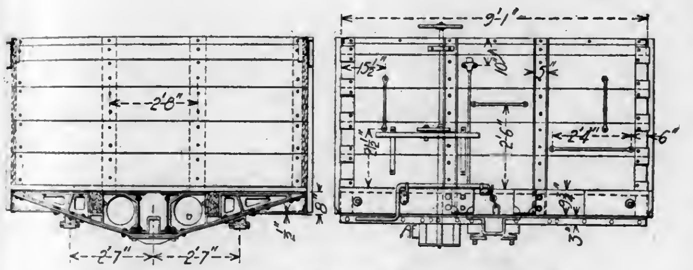
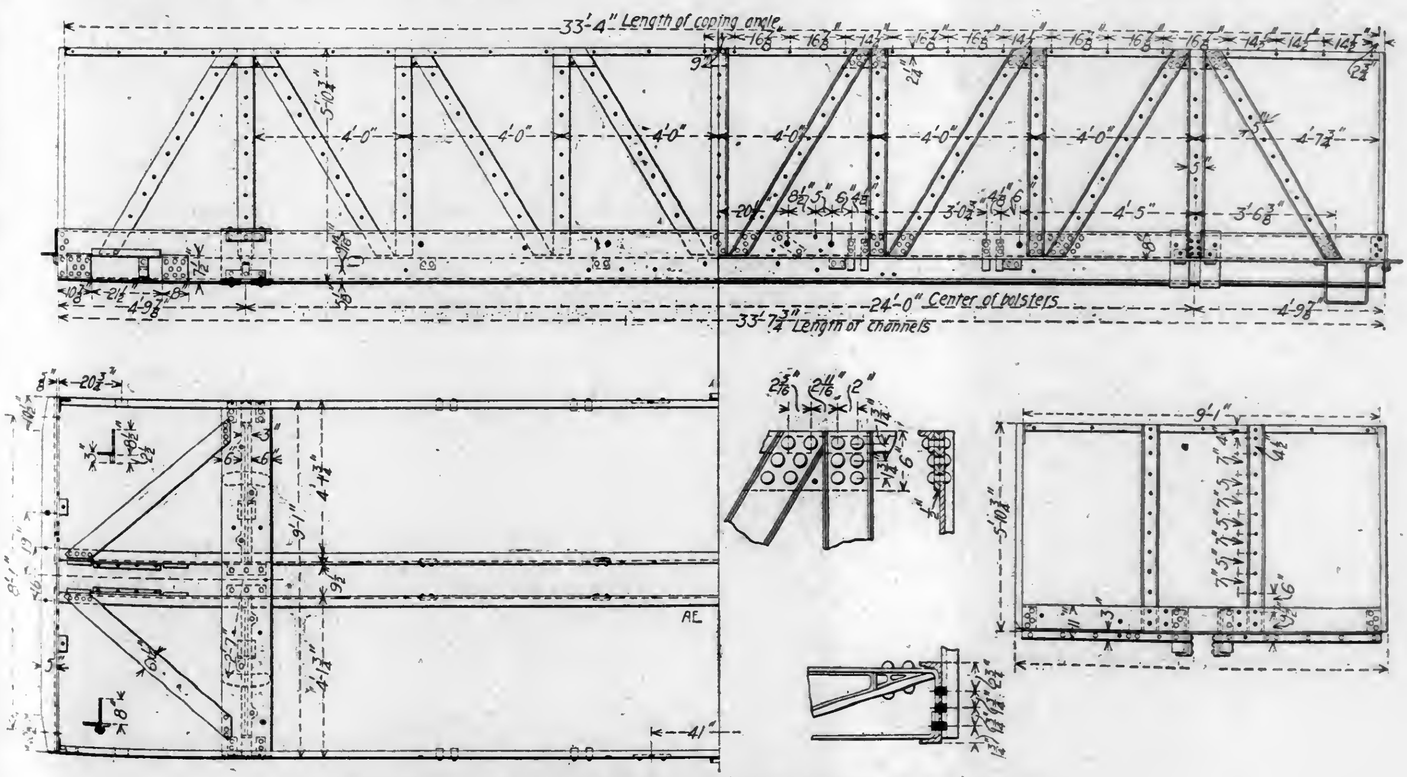


Fig. 3.—Transverse Section Showing Bolster.

type trucks, standard to the 50-ton cars. At the time the car was built the standard truck for 80,000-pound cars had not been designed. With these heavy trucks the weight of the car is 33,700 pounds, but with the new trucks this weight will be reduced to 32,000 pounds or less.

The new design of truck shown in Figs. 5 and 6 is similar in many respects to those under a large proportion of the N. & W. rolling stock. It is 6 inches shorter in wheel base than is used in the trucks under the 50-ton cars, which admits of light top arch bars, 4½ by 1½ inches, while the inverted bars are 4½ by 1⅜ inches, and the tie bars 4½ by ½ inches.



80,000 Pounds Capacity Steel Frame Coal Car—N. & W. Railway.
Fig. 4.—Plan and Elevation of Steel Framing.

The lightening process has also been applied to the bolsters, which are 10-inch 35-pound I beams, with iron spacing blocks, to the spring plank, which is a 12-inch 20.5-pound channel, and to all other details where consistent with good design.

The journals are 5½ by 9 inches, the same as are in use under N. & W. 50-ton cars, which, although not M. C. B. standard for that weight, have, nevertheless, given excellent and satisfactory service. As may be seen by the illustration, Fig. 1, the car has a very neat, trim appearance, and although its service test has not yet been extensive, the indications are that it will be very satisfactory. The Norfolk & Western are preparing to build one thousand of these cars in the near future at Roanoke. The use of wood for lining and floor is justified by the designers by the unfavorable action of the acids and moisture in coal, and owing to the use of standard sections the repairs will be greatly facilitated.

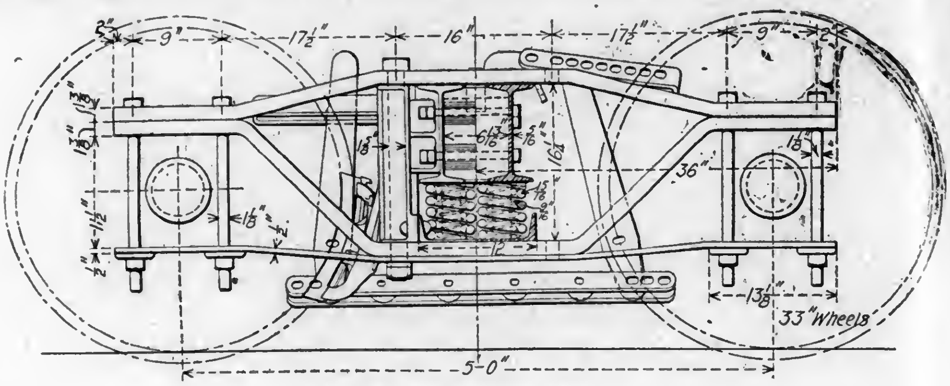


Fig. 5.- Side View of Truck.

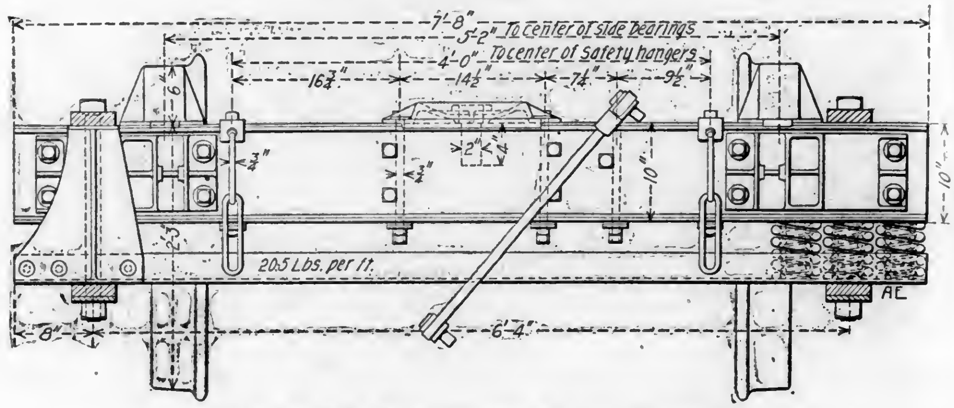


Fig. 6 —End Elevation and Section of Truck.

A CONTINUOUS MEAN PRESSURE INDICATOR.

A method of obtaining a continuous record of the mean pressure in a steam engine cylinder by pressure gauges was brought before the Institution of Mechanical Engineers about two years ago by Prof. William Ripper and described in our issue of October, 1897, page 355. Prof. Ripper's plan is to use valves driven from the engine to keep a steam gauge in communication with the steam side of the piston while another gauge is kept in communication with the back pressure side. The valves simply act to throw the gauge into communication with the ends of the cylinder alternately so that one gauge is always connected to the steam side and the other to the exhaust. For complete records of his work the paper may be consulted as reprinted in "Engineering," December 15, 1899, page 771, and the following issue.

This method seems to give surprisingly accurate results. The mean pressures are read on the gauges and to obtain a steady reading two throttling cocks are used, one close to the valve, referred to above, and the other close to the gauge. Prof. Ripper says: "By the use of these regulating cocks the oscillations of the finger of the gauge may be reduced to any desired degree of steadiness without interfering with the accuracy of the reading of the mean pressure." Despite the fact that the author of the paper expects engineers to object to the method as inaccurate for the determination of such an important factor as the mean effective pressure of an engine, he has come to the conclusion that "readings by a pressure gauge may be obtained which are as accurate, as consistent and as reliable as by any known instrument for the measurement of pressure, not excepting the best of indicators; also that throttling, when properly applied, does not endanger the accuracy of the reading, but, on the contrary, gives the true mean effect of the regular successions of momentary variations of pressure acting on the gauge."

This idea will be accepted rather conservatively because it is radical, though it may prove to be absolutely correct. The throttling and gauge method would be a boom to those who test locomotives either on the road or on rollers, because of the advantage of having a continuous record. This is equally applicable in the case of any form of high speed engine with fluctuating load. In case the power of any engine changes rapidly it is impossible to obtain a record with an indicator even if a large number of diagrams are taken on one card because of the difficulty of averaging their areas. In the discussion attention was called to the fact that ordinary indicator diagrams are often taken on so small a scale that it is almost impossible to read pressures accurately and the thickness of a line represented one pound pressure. Prof. Ripper's instrument was considered to be as accurate as that.

This appears to be an important suggestion with reference to the measurement of power.

TEST OF AN ARCH BAR TRUCK FRAME.

An arch bar truck side frame was recently tested to destruction by Prof. C. V. Kerr, of the Armour Institute of Technology, Chicago, and the results were presented last month before the Western Railway Club. Three series of loads were applied by means of a 200,000 lbs. Riehle testing machine, the car journals were represented by a short piece of shafting and the loads were applied by means of short lengths of I beams. The first series begun at 4,900 lbs. and gradually increased to 45,000 lbs. Upon release the permanent set was about 1-5 in. The several series carried the load up to 75,000 lbs. with a permanent set of a little less than 0.4 inch. The load was then increased to 99,500 lbs., at which one of the journal boxes broke. A further increase of load to 155,800 lbs. caused the bolts to shear and the boxes to crumble. The boxes were not standard M. C. B. boxes but were cut away in such a manner as to weaken the structure considerably, and the frame failed sooner than it otherwise would. Prof. Kerr, as a result of this test, strongly advocates lipping the under arch bar over the ends of the upper bar in order to reinforce the bolts against shearing. The stresses imposed upon this truck frame are greater than any static load which would occur in actual service, but since it is clear that the frame tested was weakest in shearing strength the point made is a good one and it should be considered more generally than is now the case in the construction of diamond trucks.

PRAIRIE TYPE AND WIDE FIREBOX SWITCH ENGINES.

C. B. & Q. Railroad.

Prairie Type.

General Description.

The locomotive design which we illustrate herewith is one of unusual interest because it is a rather bold step in breaking down the too thoroughly established custom of adhering to narrow fireboxes for soft coal burning engines. This design was prepared and several of the engines are being built by the motive power department of the Burlington road. They are intended for service in which the capacity of the boiler governs the load hauled. They are to be used on lines with low grades, and in heavy freight service, at low speed, or for stock and merchandise trains at high speeds.

The name "Prairie Type" and designation "Class R" have been given to this engine, which is a mogul, with a pair of trailing wheels under the firebox. The novelty of the design is the combination of a wide yet deep firebox, inside frames back to the firebox, and outside frames under the mud ring. The firebox is 7 feet long and 6 feet wide. This appears to be very short, but it will certainly make the fireman's work relatively easy, and if made longer the weight on the trailers would be increased. The grate area is 42 square feet, and the question may be asked as to why it was not made larger. We are so accustomed to the extremely large grates used for anthracite coal that this grate area seems small. It is to be used for bituminous coal, and western coal at that. The experience of the Burlington with Wootten boilers some years ago has led the officers to believe that this grate area will be successful with their coal, and that it will serve to indicate the proper direction to take in future construction. It is a generous increase over usual practice, and yet it stops short of extremes.

The elevation and half plan, Fig. 1, illustrate some of the difficulties of the frame construction. The grate was placed low in order to secure depth in the firebox, and the frames were dropped at the back of the rear driving boxes as low as practicable without interfering with the height of the draft connection to the tender. The boiler drawing, Fig. 2, shows the mud ring to be 18 inches below the throat. The main frames stop under the front end of the firebox, where they are attached by keys and bolts to a heavily ribbed cast-steel cross bar, shown in Fig. 5.

Short sections of frames, with pedestals for the trailing wheels, are spliced to the cross bar, and these frames were made wider than the main frames in order to give a good arrangement of the ash pan, which is seen in Fig. 3. The journal boxes for the trailing wheels are outside of the wheels and the frames are under the mud ring. With such a low mud ring this widening of the frames seems to be necessary. The possibility for a hinge action of the frames at this cross bar is very naturally suggested by this construction. This has been considered in the design of the bar, which is strongly ribbed on both sides. The bar itself, and the frames, at the splices, are 16 inches deep, and the splices each have 12 1⅛-inch bolts. In the plan view of Fig. 1 and in Fig. 5, the form of the splice is shown. The parts are so fitted as to bring the keys in compression instead of shear. This is a very strong splice. Attention was directed to this method of keying on page 181 of our June issue, 1899. It has been in use on the Pennsylvania since 1892 and we hope it will come into general use for frame splices. The rear cross bar, also of cast steel, in which the draft iron is an integral part, is shown at the left in Fig. 5. This construction necessitated tubes 16 feet 1 inch long, although they were favored as much as practicable by the location of the tube sheets. The equalizer system and spring rigging are shown in Fig. 1. The front driving wheels are equalized with the truck, and the remaining wheels are equalized together. The trailer journal boxes have slings carrying saddles, upon which a pair of equalizers rest. The back ends of these equalizers are connected to the frames by coil springs, while the front ends are connected across the engine by a long transverse equalizer to which the equalizers which are fulcrumed under the cross bar are connected by links. This complicates the spring rigging, but it is necessary on account of the lateral offset in the frames. It is claimed, however, by the designers that the outside bearing on the trailing axle and this cross equalizer will both tend to increase the stability of the engine and diminish "rolling" or "lurching" even on soft or uneven track.

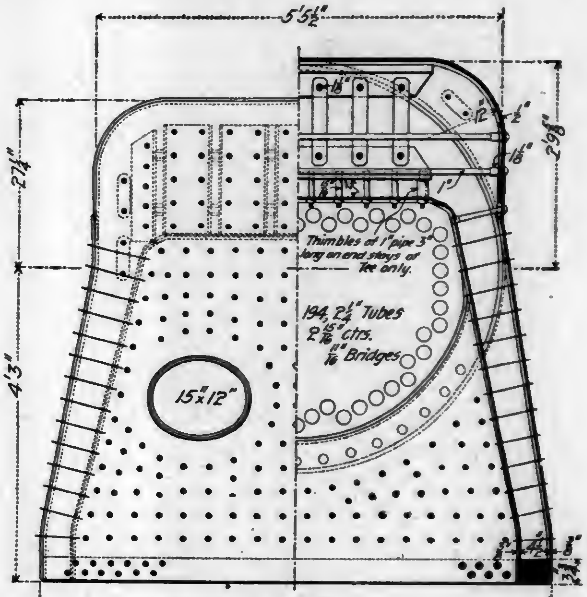


Fig. 2a.—Section of Firebox of Class R, "Prairie" Type Locomotive, C. B. & Q. R. R.

The most important dimensions are given in the following table:

Prairie Type Locomotive.
C. B. & Q. R. R.

Gauge of track	4 ft. 8½ in.
Cylinders	19 by 24 in.
Driving wheel centers	56 in.
Thickness of tires	4 in.
Engine truck wheels	37 in.
Trailing wheels	37 in.
Driving wheel base	11 ft. 4 in.
Firebox, inside	7 ft. by 6 ft.
Boiler, diameter at front end	56 in.
Boiler, diameter at throat sheet	66 in.
Heating surface, tubes	1,827 sq. ft.
" firebox	131 sq. ft.
" total	1,958 sq. ft.
Grate area	42 sq. ft.
Weight of engine in working order (estimated)	138,000 lbs.
Weight on drivers (estimated)	94,000 lbs.
Weight of tender in working order (estimated)	96,000 lbs.
Tender, water capacity	5,000 gals.
Tender, coal capacity	8 tons
Extreme width	10 ft.
Extreme height above rail	14 ft. 9 in.

The Boiler.

The boiler pressure is 190 pounds. The firebox is of the Belpaire type, with straight side sheets, unusually wide water spaces and relatively long staybolts. The water spaces are 4½ inches all around at the mud ring. The taper sheet of the boiler is in front and the rest of the shell is straight back to the firebox, the outside firebox sheet tapers toward the rear to save weight at the back and to give more room in the cab. (The firebox crown sheet is inclined so that it can not be entirely uncovered at any moment and the outer sheet is made parallel to it for obvious reasons). The tubes, 194 in number, are 2¼ inches in diameter and 16 feet 1 inch long. They are long because it was necessary to get the driving wheels between the cylinders and the front of the firebox. If the back tube sheet was of the usual form and the front tube sheet in its usual location, they would be about 15 inches longer. The front tube sheet is set back about 10 inches into the shell and the back tube sheet is

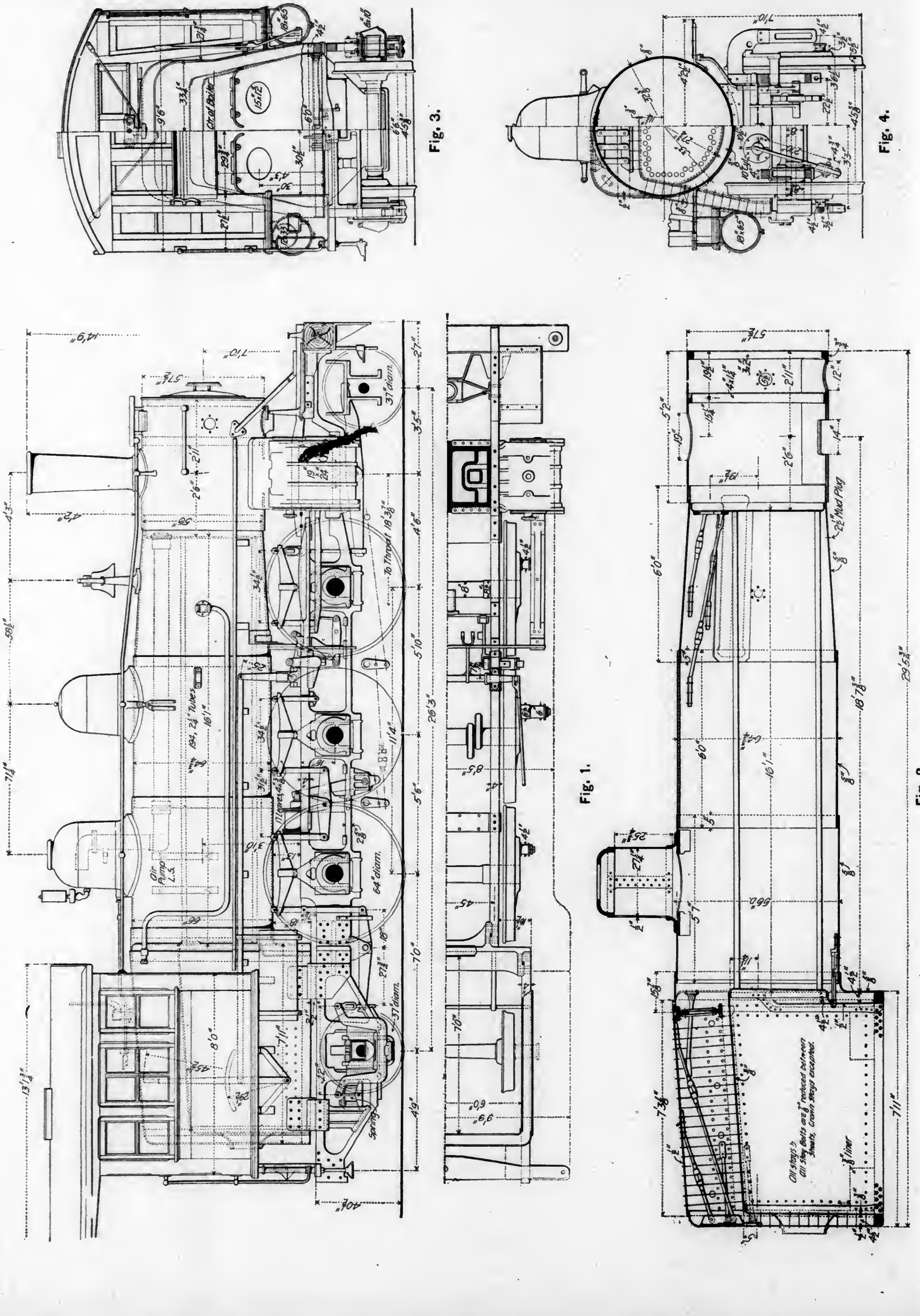
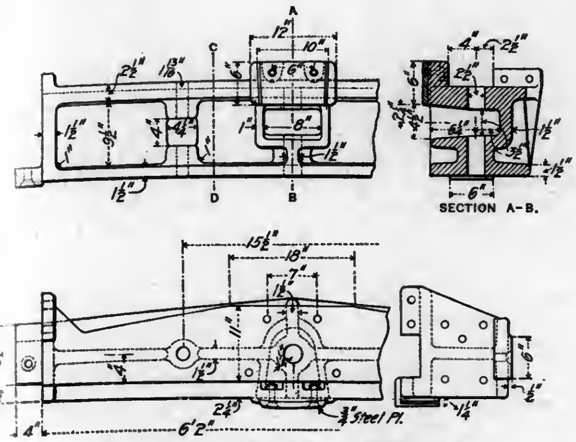


Fig. 3.

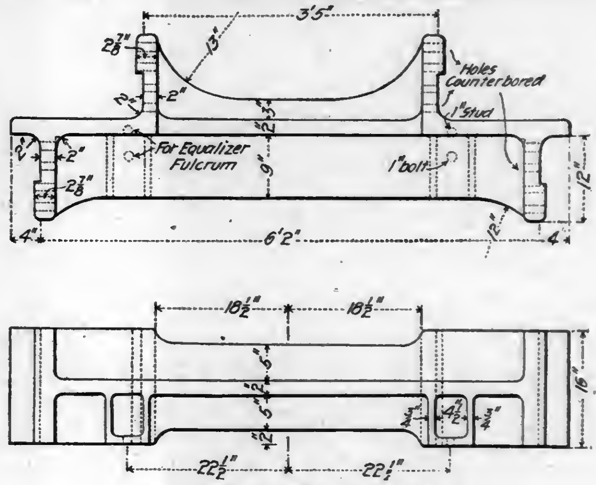
Fig. 4.

Fig. 1.

Fig. 2.
"Prairie" Type Locomotive.—C. B. & Q. R. R.



Cross-Bar at Rear Ends of Frames.



Cross-Bar in Front of Firebox.

Fig. 5

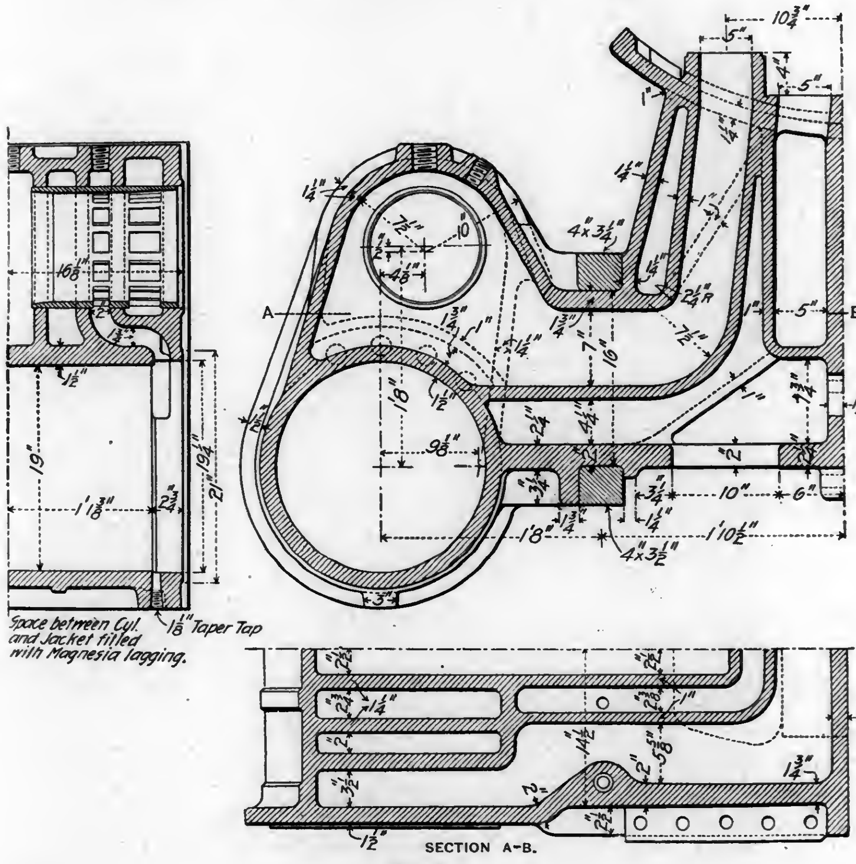


Fig. 6.

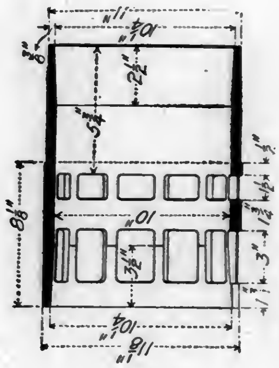


Fig. 7A.

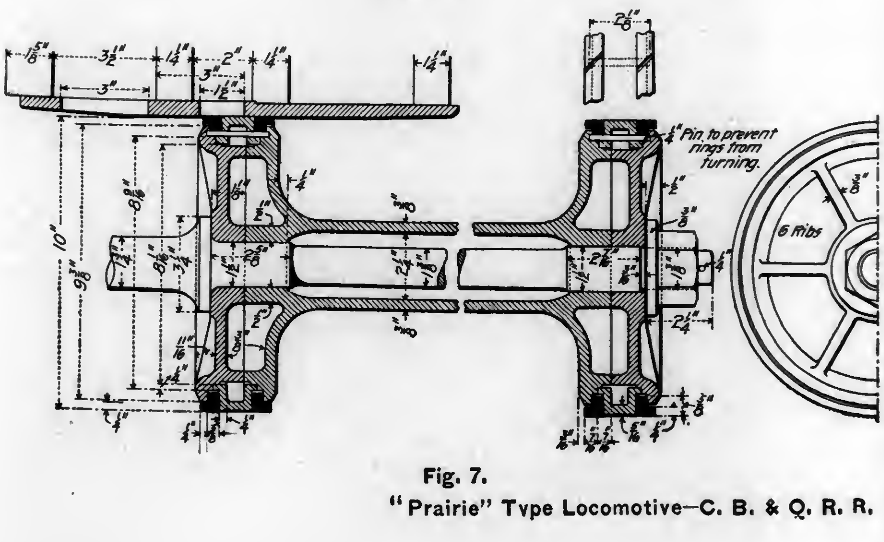


Fig. 7.

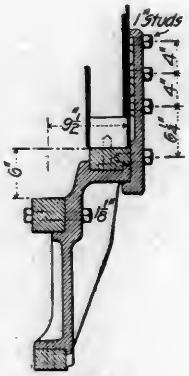


Fig. 10.

"Prairie" Type Locomotive—C. B. & Q. R. R.

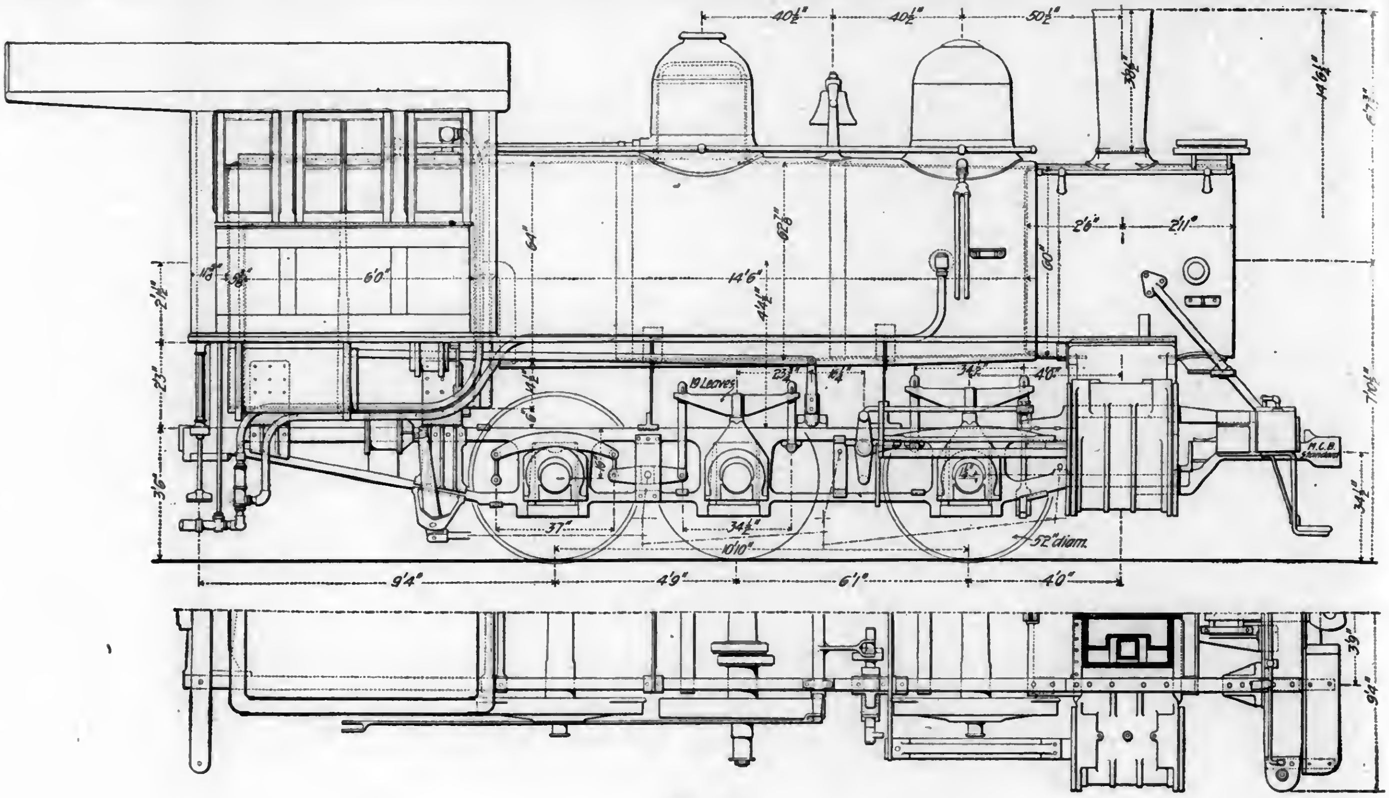


Fig. 8.

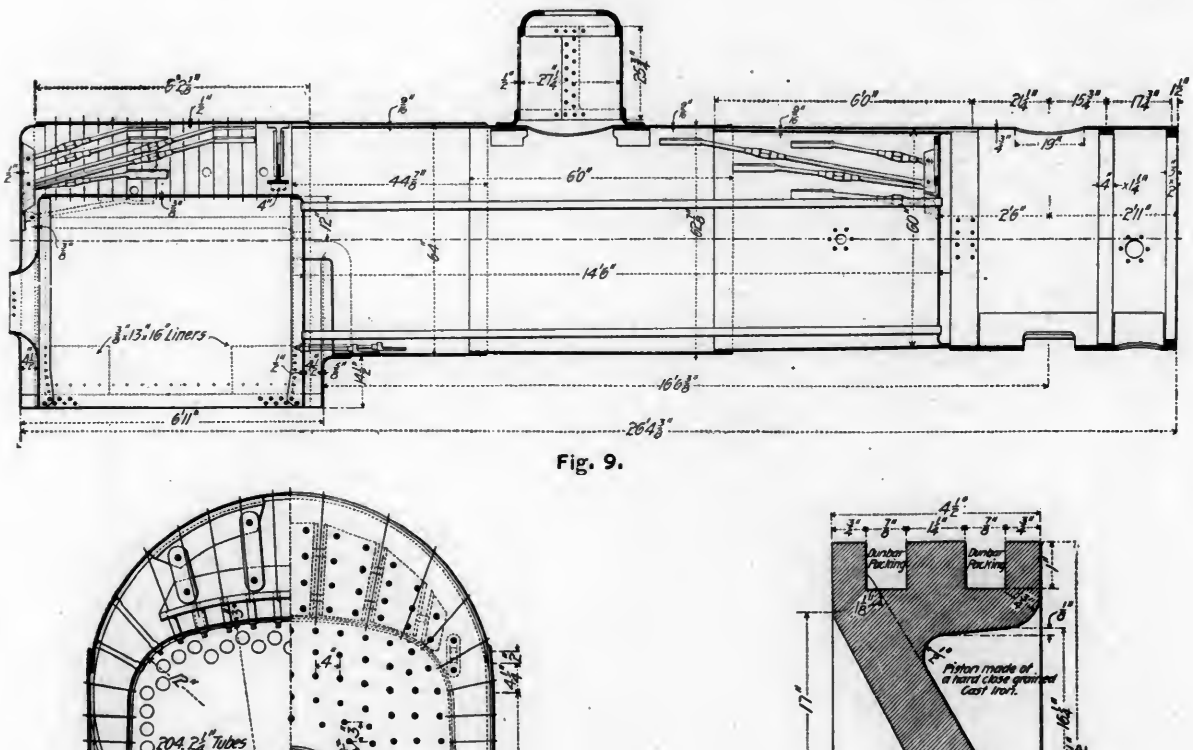


Fig. 9.

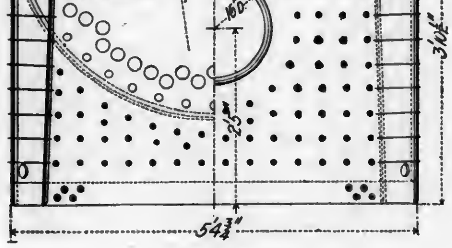


Fig. 9A.

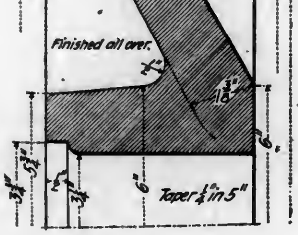


Fig. 11.

Wide Firebox Switching Locomotive.

Class "G3" C. B. & Q. R. R.

dished. This construction of the back tube sheet renders it comparatively easy to put in a new one. It removes the tube ends slightly beyond the reach of the radiant heat of the fire and adds a trifle to the length of the combustion space in the firebox.

The sectional view of the boiler shows turnbuckles in the diagonal braces. These soon become incrusted with scale in service, so as to be fast and rigid, but they are used in order to provide a close adjustment in the braces when the boilers are new. The throat stays are put in on the staybolt principle, for the purpose of obtaining a uniform distribution of the loads upon them. The firebox is provided with a brick arch, with an improved system of air ducts, in order to improve the combustion and reduce the smoke. Another feature of the firebox is the two fire doors. The clear opening into the water leg of the firebox at the throat sheet is worthy of note as being unusual.

Details of Construction.

The cylinder is illustrated in Fig. 6, and the valve in Fig. 7. The valves are upon the tops of the cylinder and the frames are double at the cylinders. The valves have internal admission and they are made solid. The packing is of the bull ring type, with small packing rings of angle section. The valve bushings have one bridge 2 inches wide which is placed at the bottom when in place. The joints in the packing bear upon this bridge, and there is no possibility of catching the ends in the ports. The other bridges are ⅝ inch wide. The Class R engines have 1 inch lap, 1/16 inch clearance and 6 inch valve travel, but the design of the valve makes any change in the lap or clearance a very simple matter.

The cross-head is the Lair type, with cast-iron top guide and a steel bottom guide. The shoes are cast iron babbitted. The pistons are cast iron, with Dunbar packing. The engine has phosphor-bronze bearings throughout. The driving axles have 8½ by 9½-inch journals, and wheel seats enlarged to 8¾ inches. The key ways are cut with a 5⅜-inch diameter milling cutter.

The air-brake cylinders are located in front of the rear driving axle, and between the frames, as shown in Figs. 1 and 4. The leading truck has a swing center and 37-inch wheels. The tender has a 5,000-gallon tank and capacity for eight tons of coal. It is carried on two four-wheel trucks.

Wide Firebox Switch Engine.

Another new design by the same road is that of the Class G 3 six-coupled switch engine, with a wide firebox and piston valves. Four of these are now building at the Aurora shops. Their chief dimensions are as follows:

Six-wheel Wide Firebox Switcher.
C. B. & Q. R. R.

Gauge of track	4 ft. 8½ in.
Cylinders	20 by 24 in.
Driving wheel centers	44 in.
Thickness of tires	4 in.
Wheel base, engine and tender	38 ft. 9 in.
Driving wheel base	10 ft. 10 in.
Firebox, inside	57¼ by 72 in.
Boiler, front end of shell	60 in.
Boiler at throat sheet	64 in.
Weight in working order (estimated)	122,000 lbs.
Weight of tender in working order (estimated)	72,000 lbs.
Capacity of tank	3,900 gals.
Capacity for coal	6 tons

This boiler differs from the one previously described. It has radial stays and is straight on top. The form of the firebox resembles that of stationary boilers of the locomotive type. There are 204 tubes, 2¼ inches in diameter and 14 feet 6 inches long. The water legs are 4½ inches wide at the bottom, and the staybolts begin to lengthen immediately above the mud ring. The turnbuckle adjustment for the braces is used in this boiler also. The method of supporting the boiler is shown in Fig. 10. This is in the form of a bracket reaching out from the frames and receiving the weight directly from the mud ring by a shoe. The side thrust is taken by a groove in the bracket, and the pad merely holds the boiler down when swayed. This appears to be an excellent boiler support. In this case a heavy bracket is necessary on account of the excess of width of the firebox over the frames.

Wide firebox switch engines have been in use for a number of years, but this is believed to be the first built for soft coal. The principal merits in this type of boiler which the designers claim is simplicity of construction, a boiler which will prove inexpensive to maintain, and lastly a very large heating and grate surface for a 6-wheel switching engine. The principal object was to overcome the difficulty with smoke in the peculiarly trying service of switching.

PRIZE FOR HIGH SPEED ELECTRIC RAILROAD PLAN.

The German Society of Mechanical Engineers will this year award the Veitmeyer prize of 1,200 marks with gold medal for the best plan and specifications for an electric railroad between two distant cities, designed exclusively for trains running at a speed of 200 kilometers (124¼ miles) per hour, and following each other in quick succession without intermediate stopping points, each train to have a minimum capacity of 150 passengers. The stipulations are given in full in the January number of Glaser's Annalen, and the contest will close on October 6th this year. The prize will be awarded at the November meeting of the society. Concerning the subject selected, Mr. Wichert, one of the prize judges and a leading German Government engineer, writes as follows:

"The problem has a special interest at the present time, as the new century now dawning may see its practical solution. The construction of railroads specially designed for light trains of high frequency and enormous speed has so far received only passing attention. Look at it as you will, it is in line with the progress of the times, but whether a practical solution is possible or not, time, study and experiments alone can demonstrate. The subject requires that careful consideration be given to the design of terminals with the necessary installation for handling trains of 200 kilometers' speed without risk or confusion. As such speeds have never yet been attained, the problem may bring out the impossibilities, if any, which stand in the way of solving it. No definite distances being laid down, the solution will not give absolute, but only relative quantities. Correct theories ought to be developed in regard to the resistance at high speeds, which in the United States have already reached 150 kilometers per hour. The problem must therefore be based on an unprejudiced review of the literature and the material at hand relating to such matters as train and air resistance, brake action, etc., referred to high speeds, and the committee having the subject in charge thinks that there is still a wide field unexplored in that direction."

Washing locomotive boilers with cold water has been considered by many as injurious to the sheets because of the sudden contraction which it causes. Mr. Edward Grafstrom, writing in the "Railway Master Mechanic," defends the practice as a result of experiments which he has made with pieces of steel cut from boiler plate. These showed no deterioration after a large number of repetitions of heating to a temperature of 260 degrees and cooling with cold water. The advocates of the use of cold water hold that there are no initial stresses in the boiler when it is cold and that the effect of the cold water is to relieve the stresses which were caused by firing up. Mr. Grafstrom does not wish to be understood as saying that local cooling is not injurious, but advocates the uniform application of cold water to promote uniform contraction.

A most interesting development of the fire tube boiler rivaling water tube boiler capacity is promised by a paragraph in a recent editorial in "The Engineer" on the subject of marine boilers, quoted as follows: "It would be premature to say much, but experiments have been carried out recently under our own eyes, with a fire tube boiler, with the result that it very readily produced its own weight of dry steam per hour; that it made nearly eight pounds of steam per pound of coal burned and that every portion of the boiler is accessible for repair, almost without removing a nut."

Mogul Freight Locomotive—New York Central R. R.

A. M. WAITT, *Superintendent Motive Power and Rolling Stock.* SCHENECTADY LOCOMOTIVE WORKS, *Builders.*

MOGUL FREIGHT LOCOMOTIVES.

New York Central & Hudson River R. R.

The Schenectady Locomotive Works have just delivered to the New York Central a number of heavy mogul freight locomotives, one of which is illustrated by the accompanying engraving. In cylinder power, size of driving wheels, grate area and in general appearance these engines strongly resemble those of the same type furnished in 1898 by the same builders and illustrated on page 363 of our November number of that year. In boiler power and weight, however, the new design far surpasses the earlier one, and as the 1898 engines have done most satisfactory work the greater power of the present design may be expected to improve upon that proportionately. The comparison in weight and boiler capacity shows progress as follows:

	1898.	1900.
Total weight, lbs.	142,200	155,200
Weight on drivers, lbs.	123,000	135,500
Heating surface, sq. ft.	2,111	2,507
Water capacity of tender, gals.	4,500	5,000

The design and specifications were furnished by the mechanical department of the road and were worked out under the direct supervision of Mr. A. M. Waitt, Superintendent of Motive Power. The details of the engines are changed from the earlier design in the use of Fox pressed steel tender trucks, cast iron taper stacks, wooden pilots and the "H" crosshead instead of the Laird. This engine has an admirable arrangement of hand holds on the engine and tender, with steps at both ends of the tender. The brake shoes are back of the driving wheels and the driver brake cylinder is under the boiler barrel instead of at the rear ends of the frames. The driving journals are 9 by 12 in. and the truck journals 6¼ by 10 in. Other characteristics of the design are included in the following table:

General Dimensions.

Gauge	4 ft. 8½ in.
Fuel	Bituminous coal
Weight in working order	155,200 lbs.
Weight on drivers	135,500 lbs.
Wheel base, driving	15 ft. 2 in.
Wheel base, rigid	15 ft. 2 in.
Wheel base, total	23 ft. 3 in.

Cylinders.

Diameter of cylinders	20 in.
Stroke of piston	28 in.
Horizontal thickness of piston	4½ in. and 5 in.
Diameter of piston rod	3⅜ in.
Kind of piston packing	Cast-iron rings
Kind of piston rod packing	U. S. metallic
Size of steam ports	18 in. by 1¼ in.
Size of exhaust ports	18 in. by 2¾ in.
Size of bridges	1⅛ in.

Valves.

Kind of slide valves	Richardson balanced
Greatest travel of slide valves	5½ in.
Outside lap of slide valves	⅞ in.
Inside lap of slide valves	Clearance 1/128 in.
Lead of valves in full gear	1/32 in. negative lead full gear forward, 3/32 in. negative lead full gear back

Wheels, Etc.

Diameter of driving wheels outside of tire	57 in.
Material of driving wheel centers	Cast steel
Driving box material	Gun metal
Diameter and length of driving journals	9 in. dia. by 12 in.
Diameter and length of main crank pin journals (main side 6¾ in. by 5¼ in.)	6 in. dia. by 6 in.
Diameter and length of side rod crank pin journals	Back 5 in. by 3¾ in., front 5 in. dia. by 3⅝ in.
Engine truck, kind	2-wheel swing bolster
Engine truck journals	6¼ in. dia. by 10 in.
Diameter of engine truck wheels	30 in.

Boiler.

Style	Extended wagon top
Outside diameter of first ring	67 5/16 in.
Working pressure	190 lbs.
Material of barrel and outside of firebox	Carbon steel
Thickness of plates in barrel and outside of firebox	21/32 in., ¾ in., ½ in. and 11/16 in
Firebox, length	108 1/16 in.
Firebox, width	40⅝ in.
Firebox, depth	F. 82 21/32 in., B. 70 21/32 in.
Firebox, material	Carbon steel
Firebox plates, thickness	Sides 5/16 in., back ⅜ in., crown ⅜ in., tube sheet 9/16 in.
Firebox, water space	Front 4 in., sides 3½ in., back 3½ in.
Firebox, crown staying	Radial stays, 1⅛ in. dia.
Firebox, staybolts	Taylor iron, 1 in. dia.
Tubes, material	Charcoal iron, No. 11
Tubes, number of	366
Tubes, diameter	2 in.
Tubes, length over tube sheets	12 ft. 2½ in.
Fire brick, supported on	Studs
Heating surface, tubes	2,321.6 sq. ft.
Heating surface, firebox	185.6 sq. ft.
Heating surface, total	2,507.2 sq. ft.
Grate surface	30.3 sq. ft.
Ash pan, style	Sectional dampers F. and B.
Exhaust pipes	Single
Exhaust nozzles	5 in., 5¼ in. and 5½ in. dia.
Smoke stack, inside diameter	16 in. at choke, 18¼ in. at top
Smoke stack, top above rail	14 ft. 6½ in.
Boiler supplied by	2 Monitor injectors, No. 10

Tender.

Weight, empty	44,700 lbs.
Wheels, number of	8
Wheels, diameter	33 in.
Journals, diameter and length	5 in. dia. by 9 in.
Wheel base	16 ft. 6½ in.
Tender frame	10-in. channel iron
Tender trucks	Two 4-wheel Fox pressed steel floating bolster type
Water capacity	5,000 U. S. gallons
Coal capacity	10 tons
Total wheel base of engine and tender	50 ft. 8 in.
Brakes	Westinghouse-American combined, on drivers, tender and for train

The boiler covering is the Franklin sectional, the brakes are the Westinghouse, and the other special equipment includes Leach sanders, National Hollow brake beams, Gould couplers, Nathan & Co.'s 1899 type lubricators, and the tenders are equipped with water scoops.

CHICAGO & NORTHWESTERN SHOPS AT CHICAGO.*

Extensive Improvements.

II.

Buildings.

The new buildings for these extensions were designed by Messrs. Frost and Granger of Chicago, and while artistic effect is not expected in railroad shops, considerable attention has been paid to their appearance, without, however, involving extravagance. The power house is the best example of this, and it is entirely appropriate. The requirements were first decided upon by the motive power officers. Then the detailed arrangements were settled, and the architects were called upon to do that which they are best able to do—design and erect the buildings. It is not unusual in cases of this kind, and especially in new shop plants, for the buildings to be designed and built by other departments, the arrangement of the interiors being left for the mechanical department to fix afterward. Such a method is never satisfactory. It results in good buildings, but they are not always convenient for those who use them.

The buildings are of brick, with steel frame roofs, that of the power house being covered with tile arches and concrete, while the others are slated. The foundations have concrete footings with stone caps. The steel work was done by the Kenwood Bridge Company, the mason work by C. W. Gindle, the cranes were furnished by Pawling & Harnishfeger of Milwaukee. Special attention was given to light and ventilation. The water closets and wash rooms for the men have been well arranged. The wash rooms have clothes lockers for the men, and the urinals and closets are placed in separate rooms. It is not necessary to show these in detail in the various shops, but it is worthy of record that good facilities of this kind, including clothes lockers and shower baths, are now considered necessary. The improvements extend these in the old shops as well as in the new.

The shops will be heated by exhaust steam from the power house, and when this is not sufficient, direct steam from the boilers will be used in addition. The intention is to concentrate the steam plant in the power house, and only such steam as is needed for heating will be taken from that building. The heating pipes are run overhead and the waste returns underground. The lighting will be by electricity throughout.

The Power House.

This building, Fig. 1, is 100 by 112 feet, and 30 feet in the clear, under the roof trusses. The basement is 9 feet 8 inches deep under the machinery room. The main walls are 25 inches thick, the roof is supported on five modified Howe trusses, the construction of which may be seen in the drawing of this detail, Fig. 2. The purlins are 9-inch 21-pound I beams, and are bolted to the trusses. The arches are 6-inch segmental tiles, with concrete filling, and composition roof covering. The roof was designed for a permanent and snow load of 100 pounds per square foot. The boiler room is 46 feet wide and the machinery room 54 feet, with a brick wall between. The roof trusses meet upon this dividing wall and on the machinery room side, it also carries an 18-inch 55-pound I beam girder for the crane support, the other support being built into the opposite main wall. The elevation of this building shows its substantial appearance and the inclined buttresses at the corners. This building has a 5-inch concrete floor, laid upon 8, 9, 10 and 12-inch I beams and brick arches. There are four 17 by 12-foot skylights in the roof, two over the boiler room, and two over the machinery room. Those over the boiler room have 30-inch and the others have 12-inch Globe ventilators. The chimney is of brick and 180 feet high. The boiler room provides for six 250-horse-power Babcock & Wilcox water-tube boilers, arranged in three batteries of two in each setting, giving at present a total of 1,500 horse power, with space for increasing this to 2,000 horse power when extended. We shall describe the boiler plant in detail in a future issue. Its arrangement is excellent. The brick chimney was decided upon after a careful consideration of mechanical draft. The original plan contemplated using three 66-inch iron stacks 107 feet high, with fans and motors, but when the cost of operation and maintenance of this system was considered it was discarded in favor of a substantial brick chimney. The reasons for this will be given more completely in connection with the description of the power questions, which will require an article by themselves. It is sufficient now to say that the chimney was found to be much cheaper than mechanical draft. There was practically no difference in first cost, while the operation of mechanical draft would be a constant annual charge. The boilers are equipped with automatic stokers, and the coal is handled entirely by machinery. It is stored in elevated bins, from which it runs by gravity to the boiler fronts. This will undoubtedly be an exceedingly economical plant in operation and in maintenance. Boilers of this type are remarkably economical in repairs.

The Boiler Shop.

This building, Figs. 3 to 6, is 120 by 300 feet, the width being the same as that of the main machine shop. The boiler shop has 14 transverse tracks connecting with the long transfer table, which also serves the locomotive shop, and over these tracks a 50-ton electric crane, with a 67-foot span, travels the entire length of the shop. At the north end of the building is the riveting tower, of which we show a section at the left of Fig. 4. The riveting and hoisting machinery for this riveting tower was described in our issue of June, 1897, page 195. It was in use in the old boiler shop. The riveter has a gap of 12 feet and works with hydraulic pressure of 1,500 pounds per square inch, so controlled as to give pressures of 25, 50 or 75 tons, as required on the work. The tower crane has a capacity of 40,000 pounds and a lift of 49 feet 3 inches. The longitudinal traverse of the tower crane is 24 feet.

This building consists of a main portion 67 feet wide by 40 feet high, and a wing 49 feet wide and 22 feet high. The wing has a traveling crane of 5 tons capacity running over its entire length, and the machinery is arranged with this in view. The cranes in both portions of the buildings are supported upon independent columns, as indicated in Fig. 6. The main walls of this building are 25 inches thick, the lighter side walls being 17 inches thick. The main roof is supported on trusses of the Fink type, shown in Fig. 6, which also shows details of the foundations. The machinery in this building is shown in a general way in Fig. 4. The crane service in this shop is admirable. The track arrangements are also good. A standard-gauge track runs through the shop lengthwise, and another across it at right angles, connecting to the transfer table. The wash room is entered from the wing of the building, and it contains 24 wash bowls, 150 lockers and two shower baths. Adjoining it are 12 closets and 14 urinals.

The Tank Shop.

The repair work on tenders has been more carefully considered in this case than is usual. A length of 144 feet has been added to the old shop, making the total length 344 feet. This shop is shown in Fig. 7. Its clear width between pilasters is 74 feet 8 inches, and it has a 30-ton traveling crane with a span of 72 feet 5 inches and a lift of 16 feet 10 inches. The walls of the new shop are 24 feet 7½ inches in height, and the walls of the old building have been raised to that height. The highest tender tank on the road is 11 feet ¼ inch over all when standing on the rails. The machinery in this shop is placed near the walls and out of the way of the cranes.

There are tracks for receiving nine tenders at a time. When they enter the shop, the tanks are lifted off by the crane and the frames, with the trucks, are moved over to the other side of the building. The truck erecting shop, with space for 20 trucks, is at the end of the building, opposite that containing the long tracks. The doors of the building are 10 feet wide by

*For the previous article on the general plan of these improvements see page 82.

CHICAGO AND NORTHWESTERN SHOPS AT CHICAGO.

Extensive Improvements.

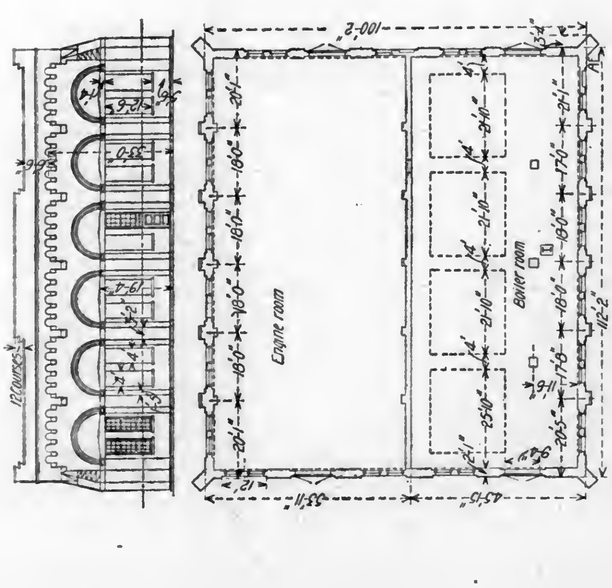


Fig. 1.—Plan and Elevation of Power House.

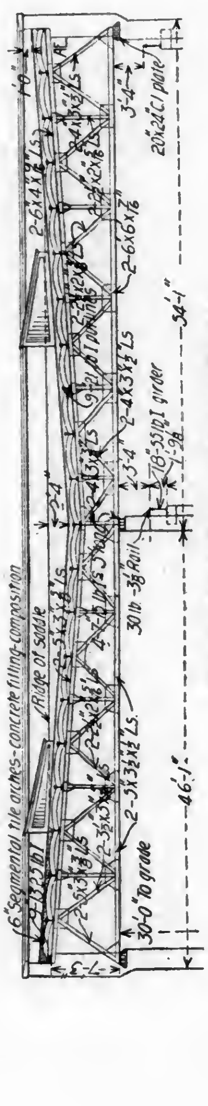


Fig. 2.—Roof Truss of Power House.

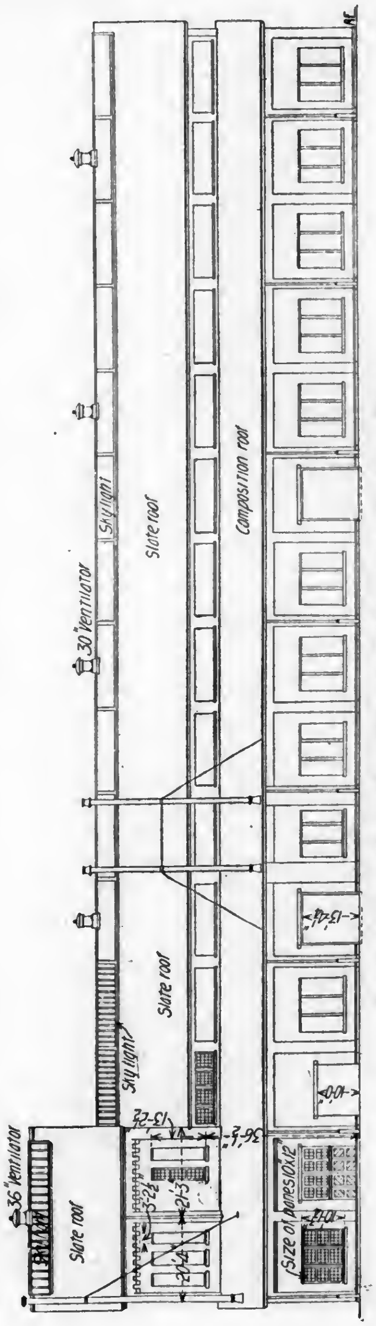


Fig. 3.—Boiler Shop—Side Elevation Showing Riveting Tower.

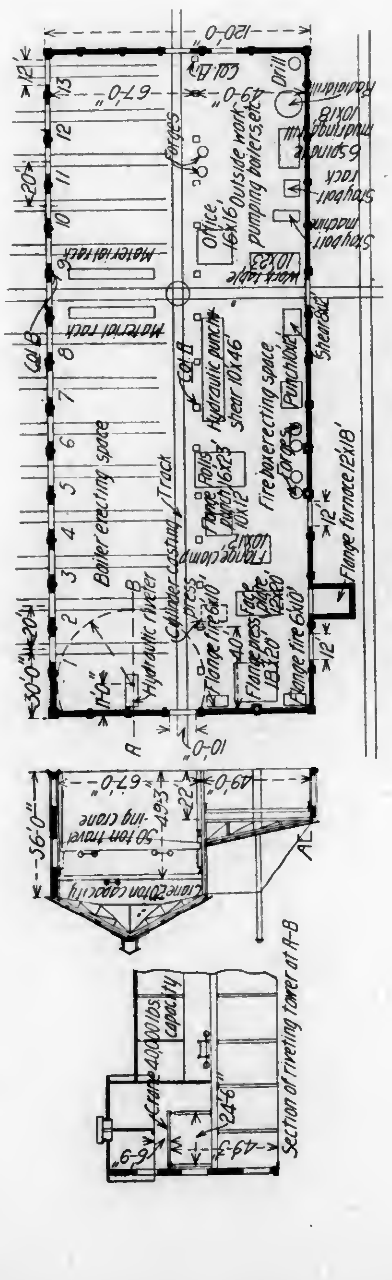


Fig. 4.—Plan and Sections of Boiler Shop.

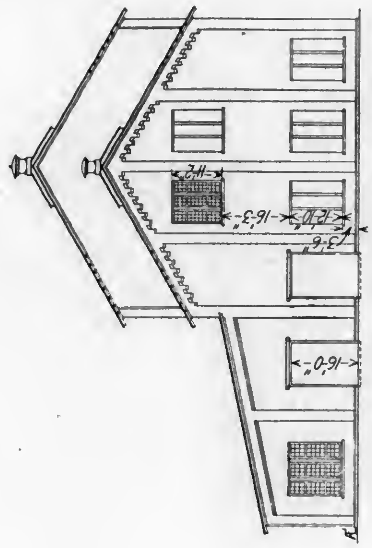


Fig. 5.—Boiler Shop—South End Elevation.

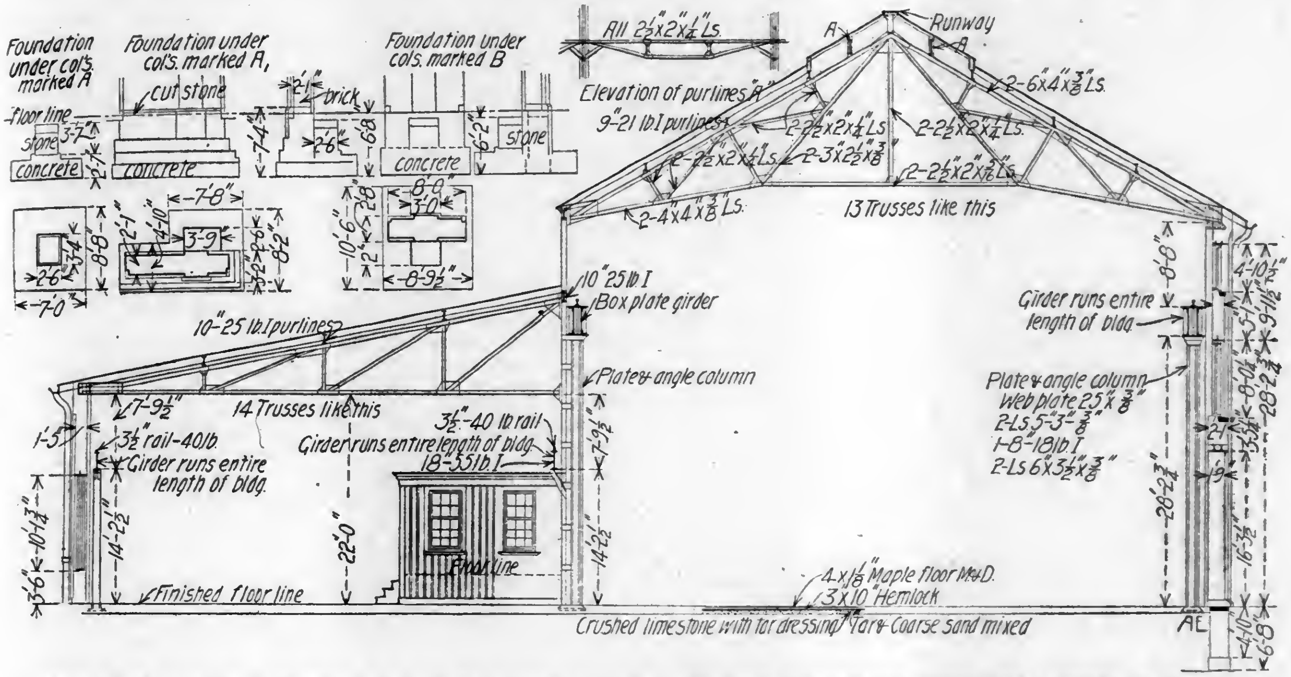


Fig. 6.—Boiler Shop—Section of Roof and Crane Columns Showing Foundations which are Located in Fig. 4.

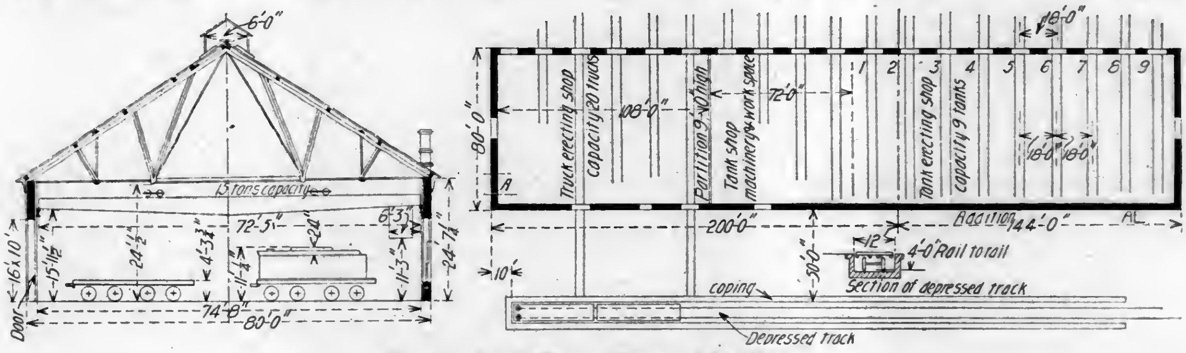


Fig. 7.—Tank Shop—Plan and Section.

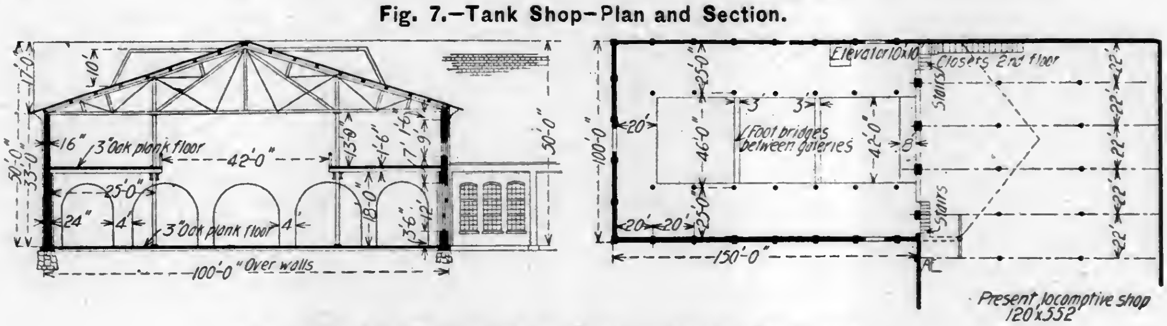


Fig. 8.—Machine Shop—Annex Plan and Sections.

CHICAGO AND NORTHWESTERN SHOPS AT CHICAGO.

Extensive Improvements.

16 feet high. On one side of the building is the transfer table, and on the other, running its full length, is a track depressed 4 feet below the surrounding ground. This is for unloading wheels, and it is placed 50 feet from the shop, which gives a large amount of room for storage. The walls of this building are 18 inches thick. It has five ventilators 12 feet long by 6 feet wide. Adjoining this shop is a 33 by 24-foot building containing the wash room, with 20 wash bowls and 150 lockers, and, in a separate room, 10 closets and 9 urinals.

The Machine Shop Annex.

Such work as turning up crank pins, making new parts of engines, brass work, bolts and rods, usually interferes seriously with the heavier work of a shop, and by being scattered all about it is a source of expense and annoyance, which will be entirely done away with in these shops by concentrating it all in this machine shop annex, a building 100 by 150 feet, as shown in Fig. 8. This is a two-story building adjoining the machine shop. The upper floor is in the form of a gallery, 25 feet wide on the side and 20 feet at the end. There are two 3-foot bridges and an 8-foot passage across. The lower story is 18 feet 6 inches high in the clear, and the upper one 13 feet. The opening in the floor is 42 by 132 feet. The walls for the lower story are 24 inches thick and those for the second story are 16 inches. A 10 by 10-foot elevator of 5,000 pounds capacity is provided in this shop. There are nine skylights, 10 feet high at the ends and 20 feet long on the ridges. The end door is 16 by 12 feet, sufficient for taking a box car into the building. The floors are of 3-inch oak plank. All piers and foundations are built on concrete.

We shall present the power plant, and information concerning the electrical distribution, in our next article on this subject.

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At one time cars with frames of commercial sections were very prominent among the promising designs for large capacity, but of late comparatively few have appeared. This seems strange in view of the strong inclination in several quarters to prefer wood to steel for flooring and siding, particularly in cars which are to be used for coal traffic. In this issue we print a description of an interesting steel frame coal car, which is not only attractive in appearance but is worthy of study from a structural standpoint. This car was designed under the direction of Mr. W. H. Lewis, Superintendent of Motive Power of the Norfolk & Western, by Mr. C. A. Seley, Mechanical Engineer of that road, and it is illustrated fully in this number. This car is a high-sided coal gondola, with a nominal capacity of 80,000 pounds. It has a steel frame, with wooden floor and sides and drop doors. With two heavy trucks designed for cars of 100,000 pounds capacity, weighing 15,500 pounds, this car weighs but 33,700 pounds, and with its own trucks, which will be much lighter, the weight will be reduced from that amount. The center sills are 15-inch channels and the side sills 8-inch channels. The stakes of the sides are arranged in the form of trusses, riveted to the side sills and to gusset plates at their upper ends. The upper row of rivets in these connections also take in the lower flanges of heavy angles which serve as compression members of the side trusses. The truss side frame is not a new idea in car construction, but it is a new application in this case, and it will be watched with considerable interest. This design shows the possibility of combining wood and steel in simple construction without involving excessive weight.

CRANES.

The concentration of engines, boilers, air compressors and electric generators into one building, whereby six separate steam plants are eliminated, is a striking feature of the improvements now being made at the Chicago shops of the Chicago & Northwestern. This will probably appear to many as the important accomplishment of this admirable work. Without the slightest intention of underrating the saving in fuel and in wages which this will accomplish, it is believed that the saving through the improved crane service in the new buildings will far outweigh that of the improvement in the production and distribution of power. Here is a plant in which the heavy boiler work for 1,185 locomotives is to be done. This boiler shop will be a busy place, and the economy of its operation, as well as its real capacity, will depend upon the promptness with which the heavy parts are handled and the men supplied with work. It will not do to make them wait. This shop was designed with a view of utilizing electric traveling cranes, and so also was the tank shop, which forms a part of the same plan, described in this issue. There is nothing at all remarkable in this fact except that it was not done at least five years ago. A sensible and substantial crane service is so seldom seen in a railroad shop as to make a case of this kind stand out boldly. It is strange that this is so, because no one can fail to see that the cost of locomotive repairs depends very largely upon the use of labor-saving appliances and the employment of every facility for keeping the men and machines constantly supplied with work and material. It is beyond belief that a mechanical officer of any large road in this country to-day does not appreciate crane service. It is entirely beyond comprehension why one of them put an elaborate drop pit in a new erecting shop and made no provision whatever for cranes even in the future, but this has just now been done. It was, moreover, pointed to with pride. The crane is undoubtedly the most valuable machine in a modern engineering establishment because it increases the output of every individual machine tool in the plant and adds to the capacity of every department in which the actual work is handled.

AN IMPORTANT STEP TOWARD WIDER FIREBOXES.

There are unmistakable signs of a turning toward wider fireboxes for bituminous coal-burning locomotives. For several years it has been apparent that the necessity for more grate area has been forced upon the leaders in locomotive improvement, and with this issue we are able to record an important practical step in this direction in two designs of wide firebox engines on the Burlington.

These fireboxes are not extremely wide, but that the mud ring has at last been deliberately spread beyond the limits of the frames of a soft coal-burning engine is cause for congratulation and commendation. The designs mentioned, and particularly the "Prairie type," are rather bold, and the arrangement of the frames will probably bring out some differences of opinion. This, however, is a mere detail which cannot adversely affect the general proposition that larger grates are necessary, and that they will be used. In this case the construction is strong and there is no reason to fear or expect other than satisfactory results. It is maintained that the firebox will be brought outside of the lines of the frames and various satisfactory ways will be found for accomplishing

it. It is not inconceivable that the frame construction at the firebox will be entirely revised. If it is necessary to keep the back ends of the frames out of the way of ash pans, on account of the desirability of depth in the firebox, it is possible to secure a decided advantage in construction by such a method as this of the Burlington Prairie type, with the addition of diagonal braces across the frames under the grates. The absence of the rigid bracing of the rear ends of the frames, formerly afforded by the heavy foot plates of earlier design, is making itself felt and the strong crossbar of the Prairie type, with some method of diagonal stiffening, should receive considerable thought as a possible relief from the troubles caused by the flexure of frames. It is believed that this construction can be made satisfactory even if it is not so in this design.

It is perhaps worth while to look into the supposed necessity for deep fireboxes. If they could be made shallow for bituminous coal burning on wide grates the wheel and long tube problems would be very much simpler, because the mud ring could be placed high enough to get moderate sized drivers under it.

In this connection it is well to consider the fact that bituminous coal is successfully burned in relatively small cylindrical furnaces in marine practice, which represent exceedingly shallow fireboxes. The rates of combustion are lower in marine service, but that which corresponds to the crown sheet is almost in the fire, it is so low. It is desirable to have plenty of combustion space, but it may, and probably will, be sufficient to put in into the form of length rather than depth. There is no difficulty in disposing of the driving wheels of the Columbia type without using excessively long tubes, but with six or eight wheels connected the case is different, unless the driving wheels are small.

In the Atlantic type, if the wheels are as large as those of the Baldwin engines on the Burlington, the tubes must be at least 16 ft. long. There is no apparently good objection to this when the diameter is correct. This length is necessary partly on account of large wheels and partly because of the four-wheel truck in front.

The Prairie type engine is regarded as an epoch-making design. Too much should not be expected of this individual case, but that it will show the possibilities and that it indicates the appreciation of a moderate widening of grates there can be no doubt.

SHOP TRACKS, LONGITUDINAL VS. TRANSVERSE.

The arrangement of tracks in locomotive erecting shops is almost the first question to arise in the plans for new shops or enlargements of old ones. We have inclined to the opinion in connection with large shops that where possible the tracks should be arranged lengthwise of the building, for reasons with which our readers are familiar, but in order to avoid onesidedness some arguments in favor of the lateral track plan were outlined last month. This has brought a ready response, printed elsewhere in this issue, from a superintendent of motive power who strongly favors the long tracks, and the support is so strong that it is commended to our readers. This gentleman emphasizes the importance of having two cranes in a shop anyway, for the benefit of their services in a variety of work, and he finds that the actual lifting and moving of locomotives occupies but about five per cent. of the working time of the cranes. When not used for this heavy work both cranes are available for other useful purposes which the single large crane, made necessary in the lateral plan, will not serve so well. The transfer table becomes a necessity with the lateral system, and it is considered as a serious obstacle to the handling of material to and from the erecting shop. Furthermore a transfer table cannot, like a crane, be used for assisting in the operations inside the shop. This argument is a strong one and it gives emphasis to the contention that the importance of satisfactory facilities for handling material and work in locomotive shops has been underestimated. Our correspondent points to the case of a large shop with the lateral arrangement requiring two transfer tables as an illustration of the inconvenience which they cause, and states that a shop with a transfer table upon each side is practically isolated from the surrounding buildings. At this time no case of this kind comes to mind, but the objection to two transfer tables is perfectly clear when expressed in this form. The advantage of easy supervision certainly rests with the longitudinal plan. It is believed to be exceedingly important to consider the comparative amount of general usefulness of cranes and transfer tables, both of which are expensive, in the settlement of this question. The size of the shop, the spans of the cranes, the amount of room which must be given up to the transfer table pit, all count in this connection, and it seems plain that there is a certain minimum size of plant to which the longitudinal tracks will not apply, but as the size and capacity of the shop increases the usefulness of the cranes increases, while for the same increase in size and capacity the disadvantages of the transfer table correspondingly increase.

Automatic stokers, as noted in these columns some time ago, have been tried in marine service on the Great Lakes in connection with Babcock & Wilcox water tube boilers on the steamer "Pennsylvania." This is believed to be the first installation of automatic stokers on shipboard, and the results of tests by Lieuts. B. C. Bryan and W. W. White, U. S. N., on the machinery of the ship, including the action of the stokers, are of great interest. They were published in the "Journal of the American Society of Naval Engineers" for August, 1899, and the record indicates that the stoker experiment was entirely successful. There was very little smoke, and practically none at all except when the fires were sliced and the clinkers removed. The saving in the wages of firemen and in improved combustion made possible by automatic stokers are important, and it appears to be possible and convenient to use them in connection with boilers of this type on shipboard. As the water tube boiler is making marked progress in this service it is possible that the use of automatic stokers may become equally common. In these tests it seems that the auxiliary engines for operating the stokers required but 1.68 per cent. of the total amount of steam used. It was demonstrated that the stokers could be stopped and the firing done by hand without difficulty. These stokers were made by the American Stoker Co. of Brooklyn, N. Y.

The most important facts concerning the breakage of staybolts brought to notice recently are the effects of the form of the firebox and the internal structure of the material of which staybolts are made. These were considered on page 382 of our December issue of last year and page 8 of the January issue of the current volume. In another column in the present issue Mr. R. Atkinson, of the Canadian Pacific, adds valuable support to the opinion previously referred to. In his experience it has proved advantageous to provide easy curves at the sides of the firebox and he has also found it necessary to consider the manner in which the iron is piled. That manufacturers will return to the box faggoting of 20 years ago is too much to expect. It is important that the effect of slab piling should be understood, however, and the makers should be urged to furnish iron that will be nearly equally strong in whatever direction it is bent. It is clearly impossible to place staybolts in the firebox so that they will always be bent most favorably and the proper course seems to be to select the irons which are known to be best qualified to stand the bending in any direction in which it may happen to come.

ELECTRIC POWER DISTRIBUTION.

Works of the Westinghouse Air Brake Company.

The electric distribution of power at the works of the Westinghouse Air Brake Co. at Wilmerding is an interesting installation because of its extent, its thoroughness, the use of steam turbines to drive the generators and specially because tests made before and after the change permit of knowing the advantages in economy of operation of the electric plant.

This is a case in which the saving of fuel is the largest saving because the character of the work done does not admit of the general use of individual motors, the majority of the machines requiring too little power to render this advantageous. The shafting, however, was speeded up and, therefore, a very important improvement is made upon the output of the machines. This plant is typical of a large class employing a great number of machines, and requiring but a small amount of power and located in a number of separate departments covering a large ground and floor area.

The shops were originally equipped with, for the time, an excellent system with a central boiler plant furnishing steam through underground steam pipes to 30 Westinghouse steam engines varying from 5 to 225 horse power and located in the various buildings with a view of reducing the belting to a minimum. It involved a large amount of steam piping, however. This plan was considered preferable to a smaller number of larger engines. It has always operated satisfactorily but the huge increase in the output of the works had very nearly reached the limit of the capacity of the boiler plant and this offered the desired opportunity for making the radical change which has been recently carried out. The manner of making the change itself is notable because the motors and turbo-generators were installed while the plant was running and without a minute's delay in the regular work of the shops. It was necessary merely to take off the engine belts and put on those for the motors and the change was made. The preliminary work was so thorough that it was not necessary to make a single change in the motors, the wiring or accessories after the electric system was put into operation. This means that the measurement of the power of the engines and the subdivision of the shafting for motor driving was done so well as to require no revision.

The plan shown in Fig. 1 serves to locate in a general way the factors in the system. For such a large establishment the arrangement is compact and of course if the buildings were separated by longer distances the saving in cost of operation would be greater. With about 4,000 linear feet of steam line the condensation to the engines amounted to 50 boiler horsepower, which was a constant loss. This is in spite of the fact that the piping was all well protected. This engraving shows the location of the engines by means of small circles made in black, and a glance shows what an amount of steam piping was involved. The new system places all the power and lighting generators in the power house and when in complete working order the single boiler plant and the three turbo-generators will furnish the light, heat and power for the entire establishment.

The boiler plant consists of two sections of Babcock & Wilcox boilers having 16 single boilers in all with a total capacity of 2,000 horse power. They are fed by Roney stokers and work under a pressure of 125 lbs. Run of mine coal is burned. The grate surface of each boiler is 25 square feet, the total for each half being 200 square feet, the heating surface of each boiler is 1,320 square feet or a total of 10,560 square feet. The ratio of grate area to heating surface is 52.8. No change is made in the boiler plant, which is arranged in two batteries of 8 single boilers each.

There were 30 engines in the shops located as shown in Fig. 1 and in the table below. The sizes and power of each are stated, the total nominal horse-power of the engines being 1,375. They were all operated without condensing.

NUMBERS, SIZES AND LOCATIONS OF ENGINES.

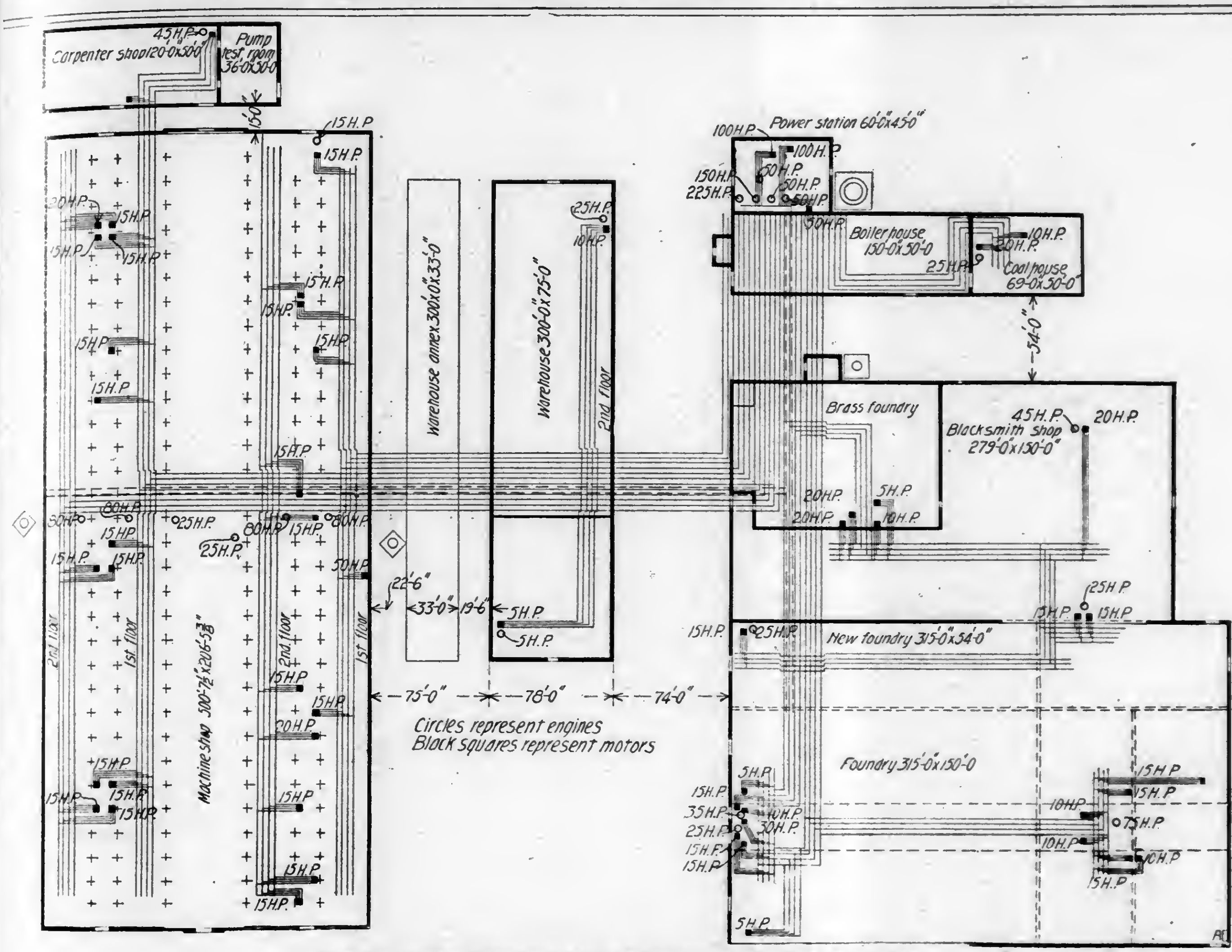
	Size.	Locations.	Purpose.	H.P.
Light Station.	16 and 27x16"	1st from entrance.	2,500 light machine.	225
	11 and 24x14"	2d " "	1,500 " "	150
	9 and 15x9"	3d " "	500 " "	50
	9 and 15x9"	4th " "	60 arc "	50
	12 and 15x9"	Centre of floor.	Generator.	50
Boiler House.	4½x4"	1st left from entrance.	Roney stokers.	5
	4½x4"	2d " "	" "	5
	4½x4"	3d " "	" "	5
	4½x4"	4th " "	" "	5
	5½x5"	1st right from entrance.	Rotary water pump.	10
	9 and 15x9"	2d " "	Hot and cold air fan.	50
	7½x7"	Rear of boiler room.	Coal crusher.	25
Blacksmith shop.	9½x9"	Boiler shop.	Boiler shop machinery.	45
	6½x6"	Rear of smith shop.	Buffer drop.	20
Iron Foundry.	7½x7"	Rear of smith shop.	Flask con. and sand elev.	25
	7½x7"	Left of entrance.	Rot. air pump and sand C.	25
	12x11"	Rear side.	Cleaning barrels.	75
	7½x7"	2d floor side.	Fan for blast.	25
	8½x8"	" " "	Flask and sand conve'rs.	35
Exper'l room.	4½x4"	Experimental Dept.	Experimental machine.	5
Pattern shop.	7½x7"	....	Pattern shop.	25
Carpen't shop.	9½x9"	1st floor carpenter shop.	Carpenters' machine.	45
Machine shop.	11 and 19x11"	West side.	½ each A and C machine.	80
	11 and 19x11"	Next to fan.	½ " " "	80
	7½x7"	Fan.	Hot and cold air fan.	25
	7½x7"	"	" " "	25
	11 and 19x11"	Next to fan.	½ each B and H machine.	80
	11 and 19x11'	East side.	½ " " "	80
	9½x9"	Rotary pump departm t	Testing rotary pumps.	45
	4½x4"	Department B.	Night machinery.	5

The only steam engines which will remain permanently will be the two 10 h.p. exciter engines in the power station and those necessary to operate the stokers, air fan and rotary pump in the boiler house.

In the power station, of which several interior views were shown last month, are the three turbo-generators, two exciter units, the air pumps and condensers for the turbines and two Class D Ingersoll-Sergeant air compressors. These are arranged to belt from 100 h.p. motors. They have 18¼ and 11¼ by 14 inch cylinders with inter-coolers, and each has a capacity of 688 cubic feet of free air per minute. The arrangement of the machinery is indicated in Fig. 4. The generators are bipolar alternators running at 3,600 revolutions per minute. The armatures are designed especially for the high speed. The voltage from the large generators is 440 and that of the exciter units is 110 volts. The air pumps are driven by a 50 h.p. motor, belt connected. At the heaviest loads two of the turbine units are able to furnish all the power and also supply the lights; there is, therefore, a large margin in power under present conditions.

The wiring system is entirely underground and it follows in a general way the locations shown on Fig. 1. The switchboard in the power station has 9 panels. This was shown in Fig. 4 on page 67 of our March issue. The first, at the left, is the exciter panel, next are the three turbine panels; the meter panel, with ground detector, is next, and at the right are the four feeder panels. The first of these is for lights entirely. The second has the power circuits for the coal and boiler house, the first floor and east side of the machine shop. The third has the second floor of the machine shop and the west side of the first floor. The fourth has the blacksmith shop and foundry circuits. There are two sets of bus bars arranged to permit of connecting the generators to either. The lights may be taken from either bus bar, but the power can be taken from the upper one only.

The lighting system requires 2,500 incandescent and 60 arc lamps. The light circuits run in tunnels to transformers and



Electric Power Distribution.—Westinghouse Air Brake Works.
Fig. 1.—Plan of Buildings and Power System.

thence to the lamp circuits. The arc lamps are the Manhattan enclosed 110 volt 100 hour lamps. As the incandescent circuits carry 110 volts both kinds take current from the same circuits.

The motors are the Westinghouse induction type with no electric connection between the armatures and the circuits; they have no brushes. They are placed against posts, upon overhead timbers or in any convenient place, and beyond oiling them once a week they require very little attention.

Two independent 30 h.p. motors are used for running fans in the foundry and the others are mounted in different ways most suited to the requirements of each case. The motor drives in the machine shop are illustrated in Fig. 3. This is a two-story building, with line shafts running its entire length. In the lower story the motors are bracketed against the columns of the building where they do not occupy space that can possibly be needed. They are belted to counter shafts and thence to the line shafts in order to secure the desired speed of 112 revolutions per minute, which is an increase of 12 per cent. over the old arrangement. These motors run at a speed of 1,120 revolutions. In the second story the main shafts run at speeds of 172, 175 and 112 revolutions, and the motors are put overhead where they are entirely out of the way. The brass room line shaft runs at 172 revolutions and is belted direct to the motor without a countershaft. In the machine shop 23 sections of 3-inch shafting 15 ft. 6 in. long were dispensed with and in the blacksmith shop four sections. Four head shafts and 8 main countershafts were also saved in the machine shop by the use of motors.

The motors are started without the slightest difficulty. Near each motor is a controlling switch to which the four wires for each motor run. The smaller motors are started on the side circuits with 7/10 of the full voltage and when they are up to speed the whole voltage is used. This method is employed for motors up to 30 h.p. Auto-starters are used for the 50 h.p. motors and larger ones. The motors are run in multiple on the main circuits as indicated in Fig. 1, which shows the wiring. For testing street car air compressor motors in the machine shop a rotary converter is used. The alternating current is at 440 volts, and the direct current at 550 volts. The current for the rotary converter first passes through a two-phase regulator by means of which the direct current voltage can be varied at will from 440 to 625 volts.

The determination of the capacities of the motors was an important part of the work, which was particularly well done. In the machine shop the lines of shafting were 400 feet long and the engines drove them from the center of the shop. The measurement of power was done with indicators. First, cards were taken with one of the engines running all the machinery on one of the shafts complete. Shaft No. 1 in the machine shop required 58 indicated h.p., which was just the amount for four 15 h. p. motors. After averaging four indicator cards for the full load, the shaft was cut at the couplings (one section, estimated to require 15 h. p., at a time being cut off) and other cards taken as a check. In this way the proper location for each motor was found. Only one motor was changed after this careful work and that was on account of putting in additional machinery. The machine shop required one 50 h. p., two 20 h. p. and 24 15 h. p. motors, of which the locations for both floors are given in Fig. 1. The wires for the first and second floors are marked in the engraving and the corresponding motors are easily found. This diagram is intended to show the general plan of the wiring and motors on each circuit, but not to indicate the exact location. In all there are 57 motors

with an aggregate nominal capacity of 1,065 h. p. Of these two 100 h. p. and one 50 h. p. motors are in the power station, leaving 815 h. p. as the aggregate for the works proper, as against 1,375 nominal h. p. and 949 actual indicated h. p. under full load of the steam engines required to do the same work. The following table shows the number and capacity of each of the seven sizes of motors used:

Schedule of Motors.

Location.	No.	H.P.	No.	H.P.	No.	H.P.	No.	H.P.	No.	H.P.	No.	H.P.
Machine shop	1	50	..	..	2	20	24	15	..	..	..	..
Iron foundry	..	..	1	30	..	..	9	15	4	10	2	5
Brass foundry and blacksmith shop ..	..	..	..	..	3	20	..	..	1	10	1	5
Coal room	..	..	..	..	1	20	..	..	1	10	..	..
Carpenter shop and leather room	..	..	..	..	1	20	..	..	1	10	..	..
Boiler house	..	..	..	..	..	..	..	..	..	..	..	..
Pattern shop	..	..	..	..	..	..	..	..	1	10	..	..
Experimental room..	..	..	..	..	..	..	..	..	..	..	1	5
Power sta'tn 2-100 h.p.	1	50	..	..	..	..	..	..	..	..	..	..

Tests of Electrical and Steam Distribution.

A material advantage in economy was expected from the electrical distribution system, and in order to measure it tests were made on eight of the boilers which were first used for driving the engines and afterward for driving the turbo-generators. Care was taken to eliminate the uncertain quantities, and while some steam was used from these boilers for other purposes during the tests, the consumption was believed to be uniform in the separate series of tests with steam and electric driving. The pumps and other steam machinery requiring variable amounts of steam were isolated as far as possible, and were connected to other boilers. (See tables 4 and 5 for statement of those not isolated.) The steam and electrical tests each covered several days, and each included a Sunday, in order to secure figures for light as well as heavy loads. In the steam

TABLE 1.

Comparison of Tests of Turbine Plant.

	Steam. Lbs.	Electric. Lbs.	Difference. Lbs.	Saved. Per cent.	Av.
Combustible, day run....	57,275	37,958	19,317	33.7	
Combustible, night run..	51,011	32,989	18,022	35.3	
Combustible, Sunday....	22,726	14,691	8,035	35.3	
Combustible, Sun. P. M.	23,215	17,440	5,775	24.8	32.2
Equiv. water, day run..	492,697	332,489	160,208	32.5	
Equiv. water, night run.	476,388	279,756	196,632	41.2	
Equiv. water, Sunday...	183,683	96,124	87,559	47.6	
Equiv. water, Sun. P. M.	200,509	109,487	91,022	45.3	41.6
Dry coal, day run.......	66,679	45,905	20,774	31.1	
Dry coal, night run.....	62,386	40,660	21,726	34.8	
Dry coal, Sunday........	27,756	18,066	9,690	34.9	
Dry coal, Sunday P. M.	31,239	22,098	9,141	29.2	32.5

Proportion of loop water of water pumped into boilers, day run, S. P., 4 per cent.

Proportion of loop water of water pumped into boilers, day run, E. P., 1.6 per cent.

Note.—S. P., steam power; E. P., electric power.

tests all the engines shown in Fig. 1 were running except two of 50 h. p and one of 150 h. p for dynamos. In the electrical tests the turbines furnished all of the power except that for lighting the general office and running the arc lights in the foundry.

The water referred to in the tables as "returned by the loops," was water of condensation from the steam supply mains to the engines in Fig. 1. About 4 per cent. of the water evaporated was returned from the pipes by the loops in the steam test, and this was reduced to 1.6 per cent. in the electrical tests, due to a material reduction in the length of steam mains. This will be reduced still more when the steam engines are all taken out. When the power of the engines was measured they were loaded very nearly to their capacity, indicating 949.12 horse power, whereas the total electrical horse power at the switchboard to replace this was about 600. The boilers were tested merely as a means of measuring the fuel consumed. The coal used was all slack in these tests. The moisture runs from 4 to 7 per cent., and the ash from 15 to 25 per cent.

The tables contain the information obtained in the tests in compact form. Table 1 gives a summary of the boiler tests, showing the saving in coal and water for the electric plant and also the saving in condensation returned by the steam loops. Table 2 is a statement of the indicated horse power of

TABLE 2.

Power Required for Machinery.

	H. P.	
Machine Shop.		
Line No. 1	58.10	
Line No. 2	41.09	
Line No. 3	52.90	
Line No. 4	37.08	
Line No. 5	16.26	
Line No. 6	73.41	
Line No. 7	33.38	
Line No. 8	45.49	357.71
Iron Foundry.		
Blast fan	24.60	
Flask conveyor No. 1	14.58	
Flask conveyor No. 2	5.92	
Flask conveyor No. 3	10.53	
Sand conveyor No. 1		
Sand conveyor No. 2	8.81	
Sand conveyor No. 3	15.13	
Sand mixer	4.27	
Sand elevator No. 1, screen and conveyor	14.77	
Sand elevator No. 2, and screen	11.64	
Sand elevator No. 3, screen and conveyor	8.76	
Emery wheels	10.74	
Dust elevator and conveyor	9.85	
Cleaning barrels	9.25	
Lathe and drill press for foundry	5.00	153.85
Blacksmith Shop and Brass Foundry.		
Blacksmith shop	14.21	
Blast fan	18.02	
Exhaust fan	4.60	
Emery wheels	15.00	
Cleaning barrels, sand elevator and conveyor	6.00	57.83
Carpenter Shop.		
Leather room	5.36	
Carpenter shop	19.63	24.99
Pattern Shop.		
Pattern shop	3.42	3.42
Experimental Room.		
Experimental room	5.00	5.00
Light Station.		
No. 707 incandescent light	44.85	
No. 243 for arc light	27.55	
No. 160 load of 50 amp. and eng. friction	121.61	
No. 717 load of 55 amp. and eng. friction	152.31	346.32
Total indicated horse power		949.12

the engines which have been replaced by motors. This shows the amount of power required by the machinery, and it is reproduced in detail in order to give an idea of how thoroughly the work was done in measuring the power for operating the various lines of shafting in the shops and the various other applications of power in the foundry and other parts of the works. It also includes that required for lighting, as the machinery was arranged before the electrical application. All of this power has been replaced by motors receiving current from the turbo-generators, and all were included in the tests except those already mentioned. The exact number of lights used during the tests is uncertain. This factor varied considerably and no record was kept, but it is assumed that it varied uniformly during the different tests. Table 2, of course, includes

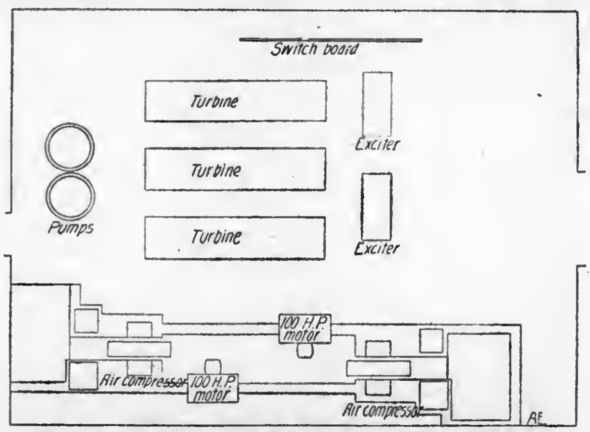


Fig. 4.—Location of Machinery in Power House.

the power consumed in internal friction of the engines. This was an additional load, which was not represented in the electrical tests. It was a legitimate part of the steam-engine load, however.

Table 3 contains a statement of the turbine tests, showing complete data obtained from the turbines, generators and ex-

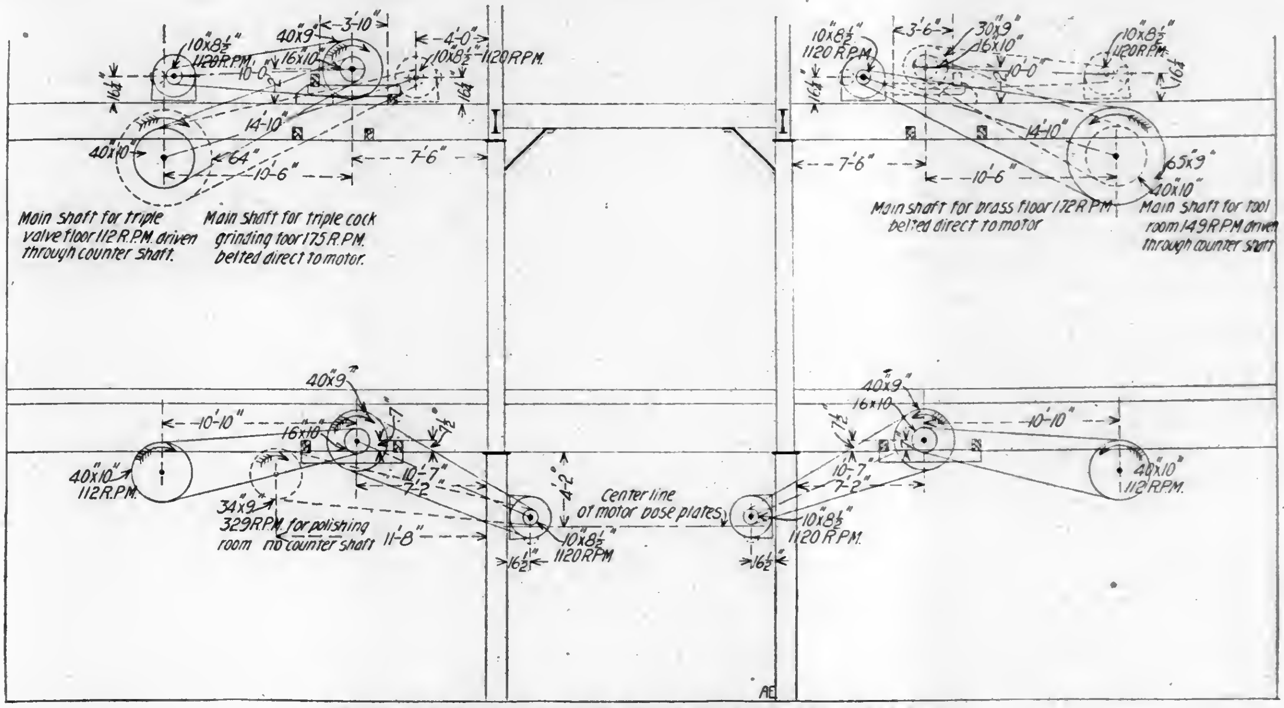


Fig. 3.—Arrangement of Motor Drives in Machine Shop.

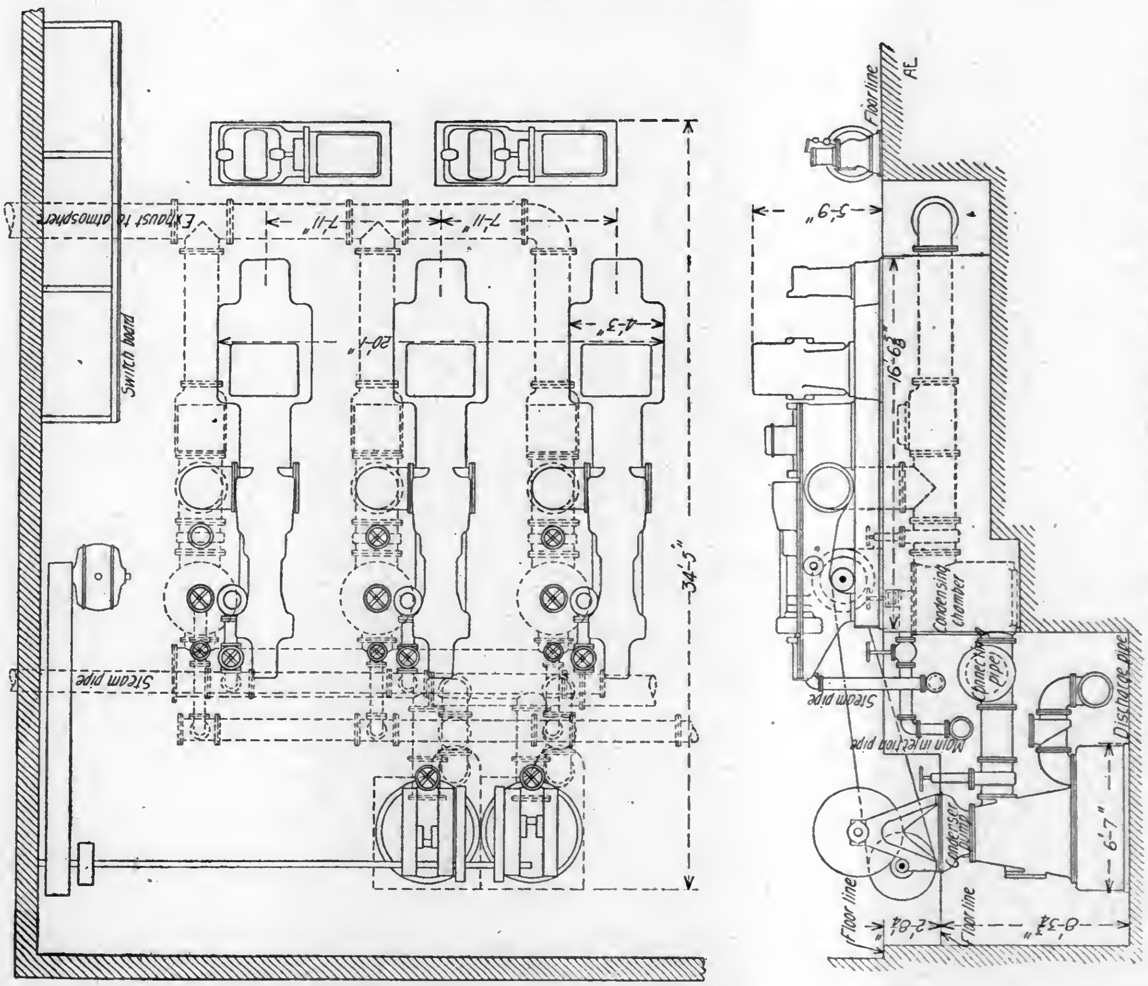


Fig. 2.—Plan and Elevation of Turbo-Generators Showing Air Pumps and Piping.

citers. These tests were run from 6.30 A. M. to 6 P. M., and from 6 P. M. to 6.30 A. M. In the night runs the power was very small as compared with the day runs, which was due to the fact that the shops are practically shut down at 9.20 P. M., with the exception of the foundry, which is in continuous operation. A wattmeter gave the total number of watts, which, divided by the number of hours, gave the electrical horse-power-hour, as shown in this statement, and indicated as "total electrical horse power." In this table the first line gives the date of the test, the turbines in use are noted, and the number of hours which each one ran. All the readings in this test were figured on a time basis. For example, February 17 the

TABLE 3.—TURBINE RECORD.

Date of test		2-15-1900.	2-15 & 16.	2-16-1900.	2-16 & 17.	2-17-1900.	2-17 & 18.	2-18-1900.	2-18 & 19	2-19-1900.
Duration of test		6:30 A.M. —6 P.M.	6 P.M.— 6:30 A.M.	6:30 A.M. —6 P.M.	6 P.M.— 6:30 A.M.	6:30 A.M. —1 P.M.	6 P.M.— 6:30 A.M.	6:30 A.M. —6 P.M.	6 P.M.— 6:30 A.M.	6:30 A.M. —6 P.M.
" " in hours		11½	12½	11½	12½	6½	12½	11½	12½	11½
No. 1 Turbine in use	Hrs	....	1½	11½	2	..				11½
" 2 " "	Hrs	11½	11	..	10½	5				11½
" 3 " "	Hrs	11½	3	11½	3	6				....
No. 1 turbine	Rev. per min.		3,600	3,548	3,579	..				3,545
" 2 "	Rev. per min.	3,560	3,574	....	3,600	3,548				3,545
" 3 "	Rev. per min.	3,560	3,546	3,548	3,538	3,556				....
Condensing pump	Rev. per min.	70	71	70	72	71				70
Steam No. 1 turbine	Pressures,	......	114.8	109.6	108.7	....	Turbines did not run.	Turbines did not run.	Turbines did not run.	107.6
" " 2 "	Pressures,	110.9	108.7	......	111.0	110.5				107.6
" " 3 "	Pressures,	110.9	106.8	109.6	108.7	110.2				......
Exhaust No. 1 turbine	Pressures,	......	28.00	27.22	27.28	....				27.66
" " 2 "	Pressures,	27.33	27.87	....	28.10	27.22				27.66
" " 3 "	Pressures,	27.23	27.86	27.22	27.32	27.38				......
Exhaust No. 1 con. pump	Pressures,	27.33	27.86	27.22	27.38	27.46				27.66
" " 2 " "	Pressures,	27.33	27.86	27.22	27.38	27.46				27.66
External air	Temp. Fahr.	37.3	27.8	26.0	26.0	21.0				20.7
Engine room	Temp. Fahr.	68.0	67.1	69.3	67.7	63.0				61.2
Condensing water intake	Temp. Fahr.	40.0	38.8	37.0	37.0	32.0				30.6
" " discharge	Temp. Fahr.	90.1	75 5	95.3	82.8	89.2				92.1
Output of indicated watts, No. 1 Turbine	Elect'l output.	....	46.	228.9	147.9	....				220.
" " " " 2 "	Elect'l output.	206.5	102.4	....	88.0	221.8				214.
" " " " 3 "	Elect'l output.	205.1	181.4	227.3	181.7	188.8				......
Voltage	Elect'l output.	440	440	440	440	440				440
Volts	Ex-cit-er.	110	110	110	110	110				110
Amperes	Ex-cit-er.	29.3	23.0	30.0	22.7	27.1				30.0
Barometer, inches		29.045	29.149	29.019	29.050	29.050				29.300
Total Elec. H. P. neglecting lamps.		578	249	619	249	477				606
		Thursday.	Thurs. P.M.	Friday.	Fri., P.M.	Saturday.				Monday.

Note.—The boiler tests were made continuously through the three half days when the turbines were shut down. This was to ascertain the comparative steam pipe condensation losses for the complete engine piping system with that required for the electrical distribution system.

TABLE 4.

Summary of Time Run and Nominal H. P., Thursday, February 5th 1900. From Monday Morning at 6.30 A. M. to Tuesday Morning at 6.30 A. M. Operated by Steam.

	Total. H. P.		Time run. Hrs.	Min.	Total H. P. Hrs.	
Machine Shop.						
3 80-H.-P. engines	240		14	7	3,388.00	
1 80-H.-P. engine	80		22	12	1,776.00	
1 5-H.-P. engine	5		22	30	112.50	
1 25-H.-P. engine	25	350	14	10	354.16	5,630.66
Leather Department.						
1 45-H.-P. engine	45	45	10	25	468.75	468.75
Boiler House.						
1 50-H.-P. arc engine	50		17		850.00	
2 50-H.-P. stoker engines	10	60	24		240.00	1,090.00
Light Station.						
1 250-H.-P. engine	250	250	17	40	1,356.66	1,356.66
Blacksmith Shop.						
1 50-H.-P. engine	50	50	23		1,150.00	1,150.00
Iron Foundry.						
1 75-H.-P. engine	75		22	55	1,718.75	
1 35-H.-P. engine	35		21	37	756.58	
1 25-H.-P. engine	25		22	50	570.83	
1 25-H.-P. engine	25		20	40	516.66	
1 25-H.-P. engine	25	185	23	10	579.16	4,141.98
Warehouse.						
1 25-H.-P. engine	25		13	58	349.16	
1 5-H.-P. engine	5	30	10	30	52.50	401.66
Total		970				14,239.71
Miscellaneous. (Not included in above.)						
Valve open on heater ¾ turn, mach. shop			9	10		
3 steam hammers, blacksmith shop			8	15		
1 steam hammer, blacksmith shop			1	40		
1 hydraulic pump, blacksmith shop			10	25		
1 hydraulic pump, iron foundry			24			
1 hot water heater, iron foundry			24			
1 steam siphon, 1-in. outlet, iron foundry			24			

steam pressures seem to be different. This is because one turbine ran five hours while the other ran six hours, giving a different average, but the pressure at any instant was the same on both turbines.

Tables 4 and 5 show the number and size of each motor and engine and the number of hours each was in operation during the tests. These statements also show the total horse power hours, based on the nominal ratings of the engines and motors. This is not important except to give the relative amount of horse power capacity employed during each test. The heading "Miscellaneous" includes various machines which were connected to the boilers during the tests, of which the horsepower capacity could not be determined. The total consump-

TABLE 5.

Summary of Time and Nominal H. P., Thursday, February 15th, 1900. From Thursday Morning, at 6.30 A. M., to Friday Morning, at 6.30 A. M. Operated by Electricity.

	Total H. P.		Time run. Hrs.	Min.	Total H. P. Hrs.	
Machine Shop.						
3 15-H.-P. motors	120		13	50	1,660.00	
1 15-H.-P. motor	15		10	20	155.00	
4 15-H.-P. motors	60		13	55	835.00	
1 20-H.-P. motor	20		13	55	278.33	
1 15-H.-P. motor	15		22	15	333.75	
4 15-H.-P. motors	60		14	5	845.00	
1 15-H.-P. motor	15		10	33	158.25	
1 15-H.-P. motor	15		21	46	326.50	
1 15-H.-P. motor	15		22	5	331.25	
1 15-H.-P. motor	15		13	50	207.50	
1 20-H.-P. motor	20		13	50	276.66	
1 15-H.-P. motor	15		11	13	168.25	
1 20-H.-P. motor	20		10	25	208.33	
1 15-H.-P. motor	15		22	30	337.50	
1 10-H.-P. motor	10		13	50	138.33	
1 5-H.-P. motor	5	435	9	58	49.83	6,309.48
Boiler House.						
2 5-H.-P. stoker engines	10		24		240.00	
1 50-H.-P. arc engine	50	60	14	30	725.00	965.00
Brass Foundry.						
1 20-H.-P. motor	20		21	15	425.00	
1 10-H.-P. motor	10		21	15	212.50	
1 5-H.-P. motor	5	35	15		75.00	712.50
Blacksmith Shop.						
1 30-H.-P. motor	30		14	5	422.50	
1 20-H.-P. motor	20	50	22	40	453.33	875.83
Iron Foundry.						
1 15-H.-P. motor	15		21	3	315.75	
1 15-H.-P. motor	15		21	3	315.75	
1 15-H.-P. motor	15		19	45	296.25	
1 10-H.-P. motor	10		21	3	210.50	
1 30-H.-P. motor	30		22	15	667.50	
1 15-H.-P. motor	15		18	38	278.50	
1 15-H.-P. motor	15		19	58	299.50	
1 15-H.-P. motor	15		21	30	322.50	
1 15-H.-P. motor	15		21	30	322.50	
1 5-H.-P. motor	5		20	53	104.41	
1 10-H.-P. motor	10		22	5	220.83	
1 10-H.-P. motor	10		22	5	220.83	
1 15-H.-P. motor	15	185	21	13	318.50	3,893.32
Leather Room.						
1 15-H.-P. motor	15		22	15	333.75	
1 10-H.-P. motor	10	25	10	25	104.16	437.91
Total		790				13,194.04

Miscellaneous. (Not included in above.)

All lights burned during tests for electric working were fed from power circuits.

	Hrs.	Min.
3 steam hammers (blacksmith shop)	8	5
1 steam hammer (blacksmith shop	1	45
1 Hydraulic pump (blacksmith shop	22	5
No. 1 hydraulic pump (iron foundry	18	50
No. 2 hydraulic pump (iron foundry	23	19
Steam siphon (iron foundry)	24	
Hot-water heater (iron foundry)	24	

TABLE 6.

Test of Babcock-Wilcox Boilers.

Date of test	2-5-1900	2-5 & 6
Kind of fuel	Slack	Slack
Duration of test	6.30 A. M.-6 P. M.	6 P. M.-6.30 A. M.
Duration of test in hours	11½	12½
Number of boilers in use—left battery	8	8
Gauge pressure in boilers per square inch	113.2	107.4
Force of draught in column of water between damper and extreme left boiler, in inches	.500	.509
Force of draught in column of water between damper and extreme right boiler, in inches	1.109	1.057
Force of draught in column of water in main stack, in inches	1.734	1.586
Water in steam loop, Fahr	195.1	192.7
External air, Fahr	33.3	33.5
Fire room, Fahr	63.2	61.0
Cold feed water, Fahr	35.3	35.0
Hot feed water, Fahr	163.5	160.8
Steam, Fahr	343.2	338.5
Moist coal consumed, in lbs	68,000	65,600
Moisture in coal, per cent	3.30	3.08
Dry coal consumed, in lbs	65,756	63,580
Total dry refuse (ashes, etc.), in lbs	8,912	12,382
Total combustible, in lbs	56,844	51,198
Average water returned to boilers by steam loop, lbs	20,016	21.358
Average water pumped into boilers by pumps, lbs	425,203	419,521
Total water pumped into boilers per pump and steam loop, lbs.	445,219	440,879
Proportions:		
Dry coal consumed per hour, in lbs.	5,718	5,086
Total dry refuse (proportion of dry coal), per cent	13.5	19.4
Combustible consumed per hour, in lbs	4,943	4,096
Total actual evaporation of water from pump and steam loop (assumed 98 per cent. dry steam), in lbs	436,314	432,061
Net deduced from preceding:		
Total equivalent water from and at 212° Fahr., in lbs	474.994	470,318
Water actually evaporated per lb. of dry coal, in lb...s	6.63	6.79
Equivalent per lb. of dry coal from and at 212° Fahr., in lbs.	7.22	7.39
Water actually evaporated per lb. of combustible, lbs	7.67	8.43
Equivalent per lb. of combustible from and at 212° Fahr., lbs.	8.35	9.18
H. P. On basis of 34½ lbs. water from and at 212° Fahr., per hr.	1,197	1,091
Number of sq. ft. water-heating surface per horse power	8.82	9.67
H. P. per sq. ft. of grate surface	5.98	5.45
Moist coal consumed (right battery), in lbs	Monday	Monday P. M.

tion of steam in these was believed to be approximately the same in both tests.

Tables 6 and 7 are the logs of the boiler tests for the days for which the consumption of power is given. Table 6 applies to the steam driving and Table 7 to the motors. In Table 8 we have the amount of water evaporated per square foot of grate surface and per square foot of heating surface per hour during the day and night runs, with the differences indicated.

While these tests will not satisfy the stickler for refinements, they show the difference in the two methods of power distribution under every-day working conditions, and that was the object sought. They show that the turbines and motors save 40,000 pounds of coal in 24 hours, including one day and one night run. This is due to the superiority of the entire electrical installation. Part of the saving comes from the turbines, part in reduced lost work, part in the prevention of steam-pipe condensation, and part in more favorable working of the boilers.

We are indebted to Mr. E. M. Herr, General Manager of the Westinghouse Air Brake Co., for furnishing facilities, information and the results of the tests in the preparation of this description. The entire installation was designed and executed under his direction.

TABLE 7.

Test of Babcock-Wilcox Boilers.

Date of test	2-15-1900	2-15 & 16
Kind of fuel	Slack	Slack
Duration of test	6.30 A. M.-6 P. M.	6 P. M.-6.30 A. M.
Duration of test in hours	11½	12½
Number of boilers in use—left battery	8	8
Gauge pressure in boilers per square inch	114.6	114.0
Force of draught in column of water between damper and extreme left boiler, in inches	.437	.245
Force of draught in column of water between damper and extreme right boiler, in inches	1.031	1.072
Force of draught in column of water in main stack, in inches	1.656	1.485
Water in steam loop, Fahr	177.1	177.1
External air, Fahr	38.6	28.6
Fire room, Fahr	65.7	60.0
Cold feed water, Fahr	45.0	41.5
Hot feed water, Fahr	159.5	171.6
Steam, Fahr	343.6	343.3
Moist coal consumed, in lbs	48,400	42,800
Moisture in coal, per cent	5.75	5.27
Dry coal consumed, in lbs	45,617	40,544
Total dry refuse (ashes, etc.), in lbs	9,012	8,000
Total combustible, in lbs	36,605	32,544
Average water returned to boilers by steam loop, lbs	5,429	5,902
Average water pumped into boilers by pump, lbs	306,828	253,678
Total water pumped into boilers per pump and steam loop, lbs.	312,257	259,580
Dimensions and proportions.		
Grate surface of each boiler, sq. ft.	25	
Grate surface, total, sq. ft	200	
Water-heating surface of each boiler, sq. ft	1,320	
Water-heating, total, sq. ft	10,560	
Ratio of water-heating surface to grate surface	52.8	
Dry coal consumed per hr., in lbs.	3,967	3,244
Total dry refuse (proportion of dry coal), per cent	19.75	19.73
Combustible consumed per hour, in lbs	3,183	2,604
Total actual evaporation of water from pump and steam loop (assumed 98 per cent. dry steam), in lbs	306,012	254,388
Net deduced from preceding:		
Total equivalent water from and at 212° Fahr., in lbs	333,447	274,681
Water actually evaporated per lb. of day coal, in lbs..	6.70	6.27
Equivalent per lb. of dry coal from and at 212° Fahr., in lbs.	7.30	6.77
Water actually evaporated per lb. of combustible, lbs	8.35	7.81
Equivalent per lb. of combustible from and at 212° Fahr., lbs.	9.10	8.44
H. P. on basis of 34½ lbs. water from and at 212° Fahr., per hr.	8.40	6.37
Number of sq. ft. water-heating surface per horse power	12.56	16.58
H. P. per sq. ft. of grate surface	4.20	3.18
Developed electrical H. P., neglecting lamps on switchboard	578	249
	Thursday	Thursday P. M.

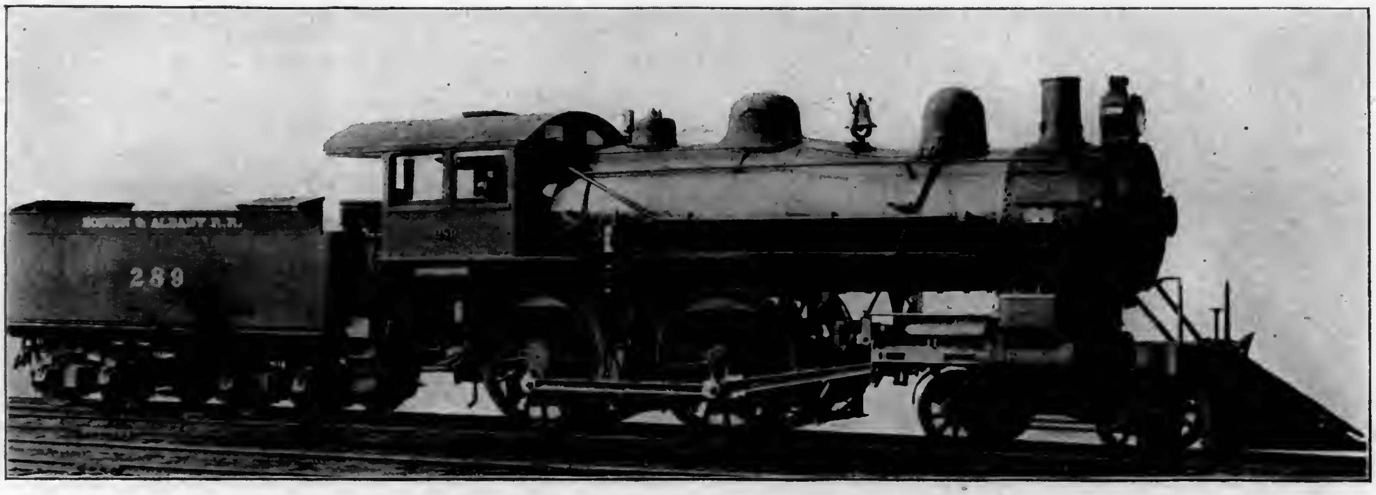
TABLE 8.

Statement of Amount of Water Evaporated.

	Steam.	Electric.	Difference.
Total lbs. water evaporated per sq. ft. grate surface per day of 11½ hours	2,463.48	1,662.44	801.04
Total lbs. water evaporated per sq. ft. grate surface per night of 11½ hours	2,381.94	1,398.78	893.16
Total lbs. water evaporated per sq. ft. grate surface per hour (day)	214.21	144.56	69.65
Total lbs. water evaporated per sq. ft. grate surface per hour (night)	207.12	121.63	85.49
Total lbs. water evaporated per sq. ft. water heating surface, per day of 11½ hours	46.65	31.48	15.17
Total lbs. water evaporated per sq. ft. water heating surface, per night of 11½ hours	45.11	26.49	18.62
Lbs. water evaporated per sq. ft. water heating surface per hour, day run	4.05	2.74	1.31
Lbs. water evaporated per sq. ft. water heating surface per hour, night run	3.92	2.30	1.62
Temperature, fire room, Fahr		63.2	61.0

The issue of March 16 of "The Railway Age" is a remarkable number. It is exceedingly valuable as a record of the proceedings of the first convention of the American Railway Engineering and Maintenance of Way Association, and contains not only the committee reports but the discussions in full. Aside from these reports the number is valuable for the record of railroad building for 1899 and that in prospect for the current year. Altogether it is a notable and creditable publication.

Large orders for locomotives have been placed since our previous issue. The Pennsylvania has ordered 40 of the Baldwin Locomotive Works for heavy freight service. The Lake Shore & Michigan Southern has ordered 25 consolidation freight and five ten-wheel passenger engines from the Brooks Locomotive Works, and among the smaller orders is one for six Baldwin compounds for the Rock Island. This is a new departure for this road.



Eight-Wheel Passenger Locomotive.—Boston & Albany R. R.

T. B. PURVES, *Superintendent of Rolling Stock*. SCHENECTADY LOCOMOTIVE WORKS, *Builders*.

EIGHT-WHEEL PASSENGER LOCOMOTIVE.

Boston & Albany Railroad.

When the Schenectady Locomotive Works built two eight-wheel passenger engines in 1894 for the Boston & Albany, with a total weight of 114,700 pounds, weight on drivers 74,000 pounds, and a total heating surface of 1,844.7 square feet, they were considered wonderful in size and power. These engines may be considered as marking the beginning of the use of large heating surfaces in engines of this type. They were followed, two years later, by engines of the same type, and same builders, for the Big Four. These had 2,175 square feet of heating surface, with a total weight of 126,000 pounds, and 83,000 pounds on drivers. The Chicago & North Western Class A engines, built in the same year, were similar to the Big Four engines, but not quite as powerful. Last year these works furnished two eight-wheel designs to the C. & N. W. (American Engineer, June, 1899, p. 189, and July, page 224), which surpassed previous designs in heating surface per unit of weight on driving wheels. The heavier and more powerful of these weighed 137,000 pounds in working order, with 87,000 pounds on driving wheels, and had 2,507.75 square feet of heating surface.

We now illustrate a new eight-wheel engine for the Boston & Albany, for use between Springfield and Boston, which, for its weight, has more heating surface than any brought out previously. This engine, with a total weight of 136,400 pounds, and 88,500 pounds on drivers, has a total heating surface of 2,505.27 square feet. It has two more tubes than the C. & N. W. engine, but no arch tubes. If these tubes were used, about 15 feet of heating surface would be added.

A matter of a few feet of heating surface seems trivial. It is so when considered by itself, but as an indication of a tendency in locomotive design it is most important. We desire to direct particular attention to the comparison between engines of the same type in six years, as follows:

Schenectady Eight-Wheel Locomotives.

	B. & A. 1894.	Big Four. 1896.	B. & A. 1900.
Total weight	114,700	126,000	136,400
Weight on drivers	74,000	83,000	88,500
Total heating surface	1,844.7	2,175	2,505.3

With an increase of 18 per cent. in total weight, the heating surface increased 35 per cent. in little more than five years.

In general the design resembles those for the C. & N. W. already referred to. It will be noticed that this is a very handsome engine. The greatest credit due to the builder is, however, the large heating surface for the weight. This was not obtained by using long tubes, for these are but 13 feet long. The chief dimensions are given in the following table:

General Dimensions.

Gauge	4 ft. 8½ in.
Fuel	Bituminous coal
Weight in working order	136,400 lbs.
Weight on drivers	88,500 lbs.
Wheel base, driving	8 ft. 6 in.
Wheel base, rigid	8 ft. 6 in.
Wheel base, total	24 ft. 8½ in.

Cylinders.

Diameter of cylinders	20 in.
Stroke of piston	26 in.
Horizontal thickness of piston	5 ft. 4½ in.
Diameter of piston rod	3¼ in.
Size of steam ports	18 in. by 1⅝ in.
Size of exhaust ports	18 in. by 3 in.
Size of bridges ports	1⅜ in.

Valves.

Kind of slide valves	Allen-Richardson
Greatest travel of slide valves	6 in.
Outside lap of slide valves	1⅛ in.
Inside lap of slide valves	0 in. line and line
Lead of valves in full gear	3/16 in. blind in full forward motion and shift backing ecc. to give ¼ in. lead at 6-in. cut-off.

Wheels, Etc.

Diameter of driving wheels outside of tire	75 in.
Material of driving wheel centers	Cast steel
Driving box material	Cast steel
Diameter and length of driving journals	9 in. dia. by 11½ in.
Diameter and length of main crank pin journals	6 in. dia. by 6 in.
Diameter and length of side rod crank pin journals	F. & B. 4½ in. dia. by 4 in.
Kind of truck	4-wheel rigid center
Truck journals	6 by 12 in.
Diameter of engine truck wheels	36 in.
Kind of engine truck wheels	Krupp No. 3

Boiler.

Style	Extended wagon top
Outside diameter of first ring	64 in.
Working pressure	190 lbs.
Material of barrel and outside of firebox	Carbon steel
Thickness of plates in barrel and outside of firebox	7/16 in., ½ in., ⅝ in., 11/16 in.
Firebox, length	108⅛ in.
Firebox, width	40⅜ in.
Firebox, depth	F. 79¾ in., B. 66¼ in.
Firebox, material	Carbon steel
Firebox plates, thickness	Sides 5/16 in., back 5/16 in., crown ⅜ in., tube sheet ½ in.
Firebox, water space	Front 4½ in., sides 4 in., back 4 in.
Firebox, crown staying	Radial, 1 in. dia.
Firebox, staybolts	Taylor iron, 1 in. dia.
Tubes, material	Charcoal iron, No. 12
Tubes, number of	344
Tubes, diameter	2 in.
Tubes, length over tube sheets	13 ft.
Heating surface, tubes	2,326.53 sq. ft.
Heating surface, firebox	178.74 sq. ft.
Heating surface, total	2,505.27 sq. ft.
Grate surface	30.33 sq. ft.
Grate, style	Rocking
Ash pan, style	Single hopper dampers F. & B.
Exhaust pipes	Single high
Exhaust nozzles	4¾ in., 5 in., and 5¼ in. dia.
Smoke stack, inside diameter	15 in.
Smoke stack, top above rail	14 ft. 4 in.
Boiler supplied by	One twin inspirator, Hancock No. 90

Tender.

Weight, empty	44,400 lbs.
Wheels, number of	8
Wheels, diameter	36 in.
Journals, diameter and length	5 in. dia. by 9 in.
Wheel base	15 ft. 10 in.
Tender frame	Iron. B. & A. standard
Tender trucks	2 4-wheel, side bearing, wood bolster and
Tender frame	Iron, B. & A. standard
Water capacity	5,200 U. S. gallons
Coal capacity	9 tons

CORRESPONDENCE.

ARRANGEMENT OF TRACKS IN ERECTING SHOPS.

To the Editor:

In the March issue of your paper, page 80, I notice an editorial on the question of arrangement of tracks in erecting shops, in which you state that some time ago you gave considerable space to the subject, rather favoring the longitudinal plan and appearing to invite support from that point of view. The criticisms which are offered and which are in favor of the transverse arrangement do not appear to have very much force, as the statements are more general than particular.

In the lateral or transverse shop arrangement only one crane can be used to lift an engine, and if the engine weighs 100 tons it requires a crane of 100 tons capacity to lift it—that is, a crane having two crabs or trolleys, each having a capacity of 50 tons. The engines are not lifted so often in the transverse arrangement, as they are not lifted in order to place them, which has to be done by other means; but, on the other hand, if the engines are placed longitudinally and two cranes each of 50 tons capacity are supplied, there are two cranes available for general purposes as against one in the other system, and as the lifting of engines does not occupy five per cent. of the time which the cranes are in service, it follows that nearly twice as much service in other work is to be had with two cranes as against one, which, as a matter of course, very much facilitates progress of work in the shop.

If the lateral system is adopted and only one crane used, it has to be supplemented by an out-door traverser or transfer table. This traverser can only be used for the handling of engines and does not facilitate the work in the shop at all, but the cost, including pit, etc., if it is arranged for quick service, is a large proportion of that of the crane of equal capacity. This traverser, being in a pit, is a great obstacle to communication between shops, and the loss of time of employees in passing around it and over the extra distance which it occupies is an unknown but important amount. The supposition that, because longitudinal tracks are used, it is necessary to lift one engine over another, is entirely wrong. This is not at all necessary, and greater height of lift is not required in a longitudinal shop than in the lateral one. In cold climates also the lateral system, which necessitates a pair of doors for each pit, is a direct drawback.

Suppose the shop was required to hold thirty engines. If these were put in one row side by side, then the shop becomes unmanageable from its length and the traverser pit is also unduly long. If they are put in two rows with engines on one side of the shop only, then one engine is in the way of the other. If they are put in two rows with the doors in opposite sides of the shop, then it requires two transfer tables and the erecting shop totally isolated from the rest of the building, unless they are put in the end, which is an inconvenient arrangement.

The most important argument of all, however, is that it is practically impossible to properly supervise a shop in which the engines are arranged laterally. If the shop is sufficiently large to fully occupy the foreman's time, it is impossible for him to give the same supervision that it is possible to exercise in a shop arranged longitudinally, where he can see the whole length of the shop when he walks across it. This is a practical observation from the writer's personal knowledge and is a serious detriment against a shop arranged laterally. The lateral system is good enough for a road which requires eight to ten engines under repair at one time, but it is not suitable for a road which has a large number of engines passing through the shops.

SUPERINTENDENT OF MOTIVE POWER.

March 5, 1900.

STAYBOLT PROGRESS.

To the Editor:

Staybolts are so important in locomotive repairs that I desire to offer a few remarks, if not too late, in connection with the article in your December number of last year, page 382, and the correspondence on page 8 of the January number of this year.

In the first place, the form of the firebox is of importance as to the number and location of staybolts broken. We have always found that a sharp "ogee" connecting the flat side of the firebox with the circular portion is extremely destructive, and it is a common thing to find a whole row or two lengthwise of the box broken off at that point, more especially with the deep class of firebox, and I presume everyone else has found the same thing. The next most troublesome part is the front upper corners and then the back upper corners and the top row across the back sheet. We have also found that an increase in the thickness of the outside plate materially increases the number of broken staybolts, and for a number of years we have never used anything thicker than 7/16 inch outside sheets, and I am disposed to think that the Pennsylvania Railroad will find an improvement by the use of ⅜ inch outside side sheets. The diameter of the bolt does not appear to make much difference, and bolts 1¼ inches or 1⅜ inches diameter appear to fail just as quickly as bolts ⅞ inch or 1 inch diameter.

We tried turned down staybolts for a year or two without any benefit that could be seen, the staybolts being turned about 1/32 inch below the bottom of the thread and carefully rounded at the ends. We have had a considerable number of engines equipped with staybolts drilled at the outer end, but have had failures occurring earlier and more prevalent than with solid bolts, and we have never derived any benefit in the way of the supposed leakage indicating a broken bolt as they are always full of mud both in the crack and in the hole.

All staybolts appear to fail by cracking across the upper and lower sides near the outside sheet, leaving a strip across the center to break off last. The upper crack usually is deeper than the lower one, and in the case of the upper corner of the side sheets the cracking is not quite horizontal but inclined a little downward toward the outer end of box. If staybolts could be made with a flat horizontal section to allow them to spring, it would appear likely to conduce to longer life.

The conclusions at the termination of the article appear to be generally correct. I have not noticed any deflection of the side sheet due to reaming, mentioned by Mr. Gillis, which may be due to the fact that the taps which we use do not have the blunt-ended reamer, but have a long tapered end to form a guide and the reamer portion is cut some distance up the shank. I quite agree with Mr. Gillis that it is almost impossible to get two staybolt taps exactly alike. We overcame this to some extent by using a pair of taps alternately, keeping each to its own vertical row, and the bolts are screwed to suit the two taps and put in the holes to correspond. We make all our own staybolt taps and keep them as nearly as possible to a standard fixed a number of years ago. Staybolts which are made of iron piled in slabs, as mentioned in your article in the middle of the second column, page 384, distinctly show the marked difference between the durability of the bolts, if the staybolt is placed in with the seams horizontally and vertically, the former being much more durable. One brand of iron particularly shows this very plainly.

R. ATKINSON,
Mechanical Superintendent Canadian Pacific Ry.

Montreal, March 9, 1900.

The first example of the ten-wheel type locomotive ever built is illustrated in a recent issue of the "Railway Age." It was built by the Schenectady Locomotive Works in 1887 and went into service on the Michigan Central R. R. in January, 1888. It is still in service.

The new passenger engines for the Lake Shore (November issue, page 344) are exceedingly handsome. The driving wheels are large, so is the boiler, which is also very long, and yet the proportions are so well balanced as to give a most pleasing appearance. One minor detail which contributes its share is the location of the headlight in advance of the stack, and yet not overhanging the front end.

New rails are being laid by the Ontario & Western, contracted for in 1898 at $18 per ton, while the same road is selling scrap rails at $33. The cost of laying the new ones is about $3 per ton, a very interesting situation for the road. The figures will change, however, when it is necessary to make new contracts, the price of new rails being now nearly $40 per ton.

ELECTRICITY AT THE DUQUESNE STEEL WORKS.

By Burcham Harding.

One of the best examples of modern direct-current "engine-type" generators is found at the Duquesne Works of the Carnegie Steel Company, twelve miles from Pittsburg. The central power station contains three 400-kilowatt Westinghouse direct-current generators, 250 volts, direct connected to horizontal tandem-compound steam engines, operating at 130 revolutions per minute. A view of the interior of the dynamo room is given in Fig. 1. In the background of the illustration are shown six direct constant-current 60-light arc dynamos, which supply current to arc lamps in the various buildings and yards. These machines are direct connected by flexible insulated couplings to six 50-horse-power shunt motors, which are operated by power from tne generators.

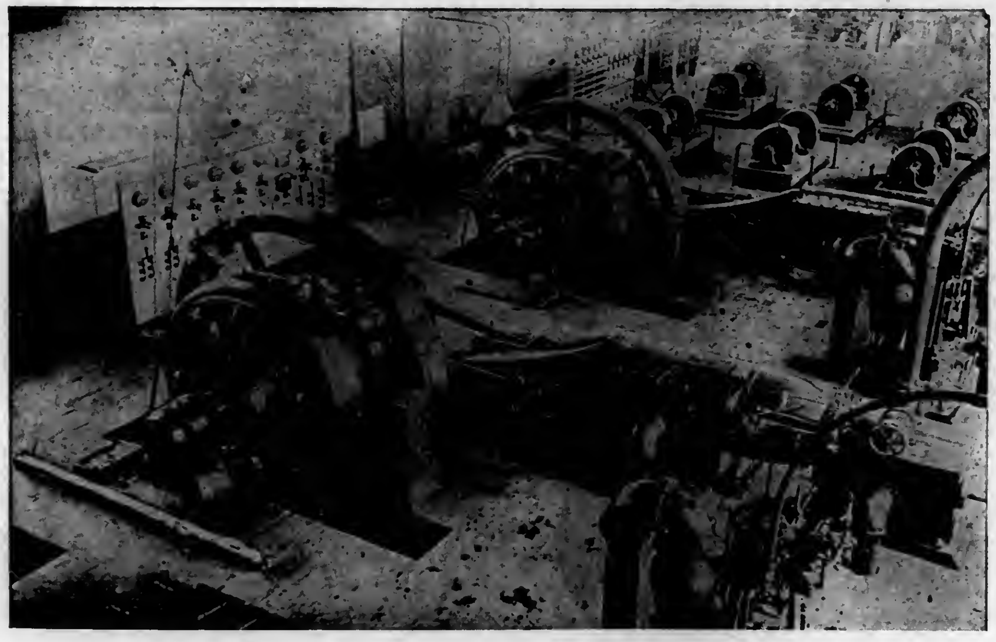


Fig. 1.—Interior of Power House. Duquesne Works, Carnegie Steel Co.

Power is conveyed to the several departments of the works, which cover an area of over 100 acres. There are over 40 electric cranes in the plant, driven by 220-volt direct-current Westinghouse motors. Other motors are used to operate the metal breaker, and for conveying iron ore from railway cars to the ore stock yard, and thence by the traveling bridges to the furnaces. In fact, electric power enters into every operation in these works.

Fig. 2.—One of the 400 Kw. Westinghouse Generators. Duquesne Works, Carnegie Steel Co.

The generators, one of which is shown in Fig. 2, represent the latest development in design and construction. They furnish current at 250 volts, and as the usual practice is to employ 220-volt motors, this allows 30 volts drop of potential in the line. The use of 250-volt generators also permits the operation of both arc and incandescent lamps from the motor circuits. The general design of these engine-type generators is similar to that for standard multipolar practice, consisting of a circular yoke carrying inwardly projecting pole pieces of laminated soft steel. The field castings are divided vertically and set upon a guide plate, the former affording excellent facility for inspection or removal of the armature or field coils.

These generators are compounded to compensate for the drop of potential in the line. The shunt and series coils are separately wound and are removable. The series coils are composed of forged copper conductors of rectangular section. The armature core consists of punched disks of carefully annealed steel, held together between end plates. This core is built upon an iron spider, which also carries the commutator. This spider is pressed and keyed upon the extended shaft and may be drawn off without in any way interfering with the permanent arrangement of the commutator and winding. Ventilating spaces through the spider and armature core are so arranged as to allow a constant circulation of air through the commutator and winding when the machine is running.

The periphery of the armature is slotted. The armature winding is made of bars of drawn copper which, after being shaped, are thoroughly insulated and baked to remove all moisture. The coils are held in the slots by retaining wedges of hard fiber, driven into notches near the top of the slots, parallel with the shaft. These fiber wedges may be pressed out should it become necessary to remove any armature coil. The commutators are constructed from the best obtainable grade of hard-rolled copper, the segments being spaced by prepared mica of such corresponding hardness that an extremely even wearing surface is presented to the brushes.

The brush-holder mechanism is carried by brackets projecting from a ring concentric with and supported by the field. A hand-wheel rocker arrangement adjusts all the brushes simultaneously. It will be noted that the ring carrying the brush-holder brackets does not project over the commutator face, thus leaving the commutator face and brushes clear of obstruction and easy of inspection at any point. Carbon brushes are used in connection with all of these machines. During construction all parts of these machines are submitted to a series of thorough tests and inspections. When assembled and completed, each machine is given a full-load running test of sufficient duration to bring it to the maximum temperature.

The electric motors operated by the current from this generating station has enabled the management to remove several separate steam engines which were very costly in the consumption of steam. It was found that many of these separate steam engines used 70 pounds of steam per horse-power hour, whereas the consumption of steam at the central power house does not exceed 16 pounds. The President of the company has stated that the intermittent operation of the motors is carried on from the central station by means of one-sixth of the horse power previously required when separate engines were used.

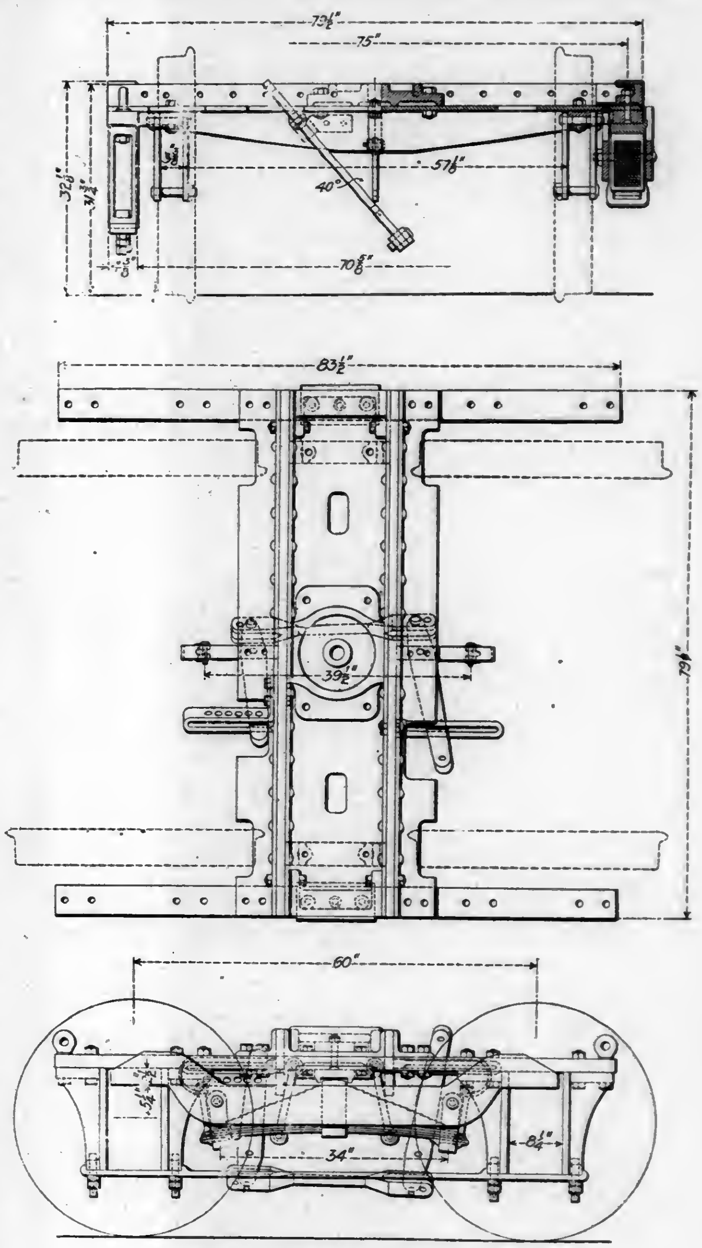
STANDARD TENDER TRUCK.

Lehigh Valley Railroad.

The Lehigh Valley standard truck for tenders using the 4¼ by 8-inch axle is shown in the accompanying engravings. The arrangement in general is not new. It is interesting, however, because of the arrangement of the details whereby the construction is simplified and cheapened and at the same time the benefits of equalization are secured. This design was brought out in 1896 and it is used on all new engines except those having 7,000-gallon tanks. These large tanks are used in connection with heavy mountain pushing locomotives and were illustrated on page 10 of our January issue. The consolidation road locomotives described on page 250 of our August issue are also to be equipped with them. The journals under these large tenders are 5 by 9 inches and Fox pressed steel trucks are used under cars as well as tenders which require these large axles.

The tender truck design was prepared with a view of requiring the minimum amount of machine work. Jigs are used to lay out and drill all the holes and the riveting is done in a pneumatic press. The side frames are made of merchant iron, unplaned, and the castings are made in such forms as to require very little machine work. The transom angles are commercial shapes with the wheel and brake lever clearances punched out. The springs are standard driving springs, by which the necessity for carrying a special spring in stock is avoided. The whole truck is made by piecework and at the lowest cost that we have ever seen. Yet the cost of maintenance is also small, which indicates that durability and safety are not sacrificed.

An examination of the drawings shows the frame rails to be of 2 by 4½ inches bar iron, the tie rod being of ¾ by 4-inch iron. The truck transom is a 15-inch channel with the flanges turned up. Outside of the flanges of this channel are 1¼-inch bars and 4 by 6-inch angles riveted together. The bars are 6 inches deep at the ends and 10 inches at the center. Clearances are cut in the angles for the wheels and the brake levers. The equalizers are 1 inch thick and 6 inches deep at the center, tapering to a depth of 5 inches at the bearing points. The springs have 19 leaves ⅜ inch thick and 4 inches wide, and are 34 inches long between bearings when under load. The height of the springs under a load of 19,000 pounds is 9⅛ inches; under 18,000 pounds, 9¼ inches; under 17,000 pounds, 9⅜ inches, and under 16,000 pounds, 9½ inches. They are designed to carry 19,500 pounds with a set of 1 inch. The axles have the M. C. B. 4¼ by 8-inch journals and journal boxes, and the wheels are 36 inches in diameter.



Standard Tender Truck.
Lehigh Valley R. R.

For the drawings we are indebted to Mr. S. Higgins, Superintendent of Motive Power, and to Mr. F. F. Gaines, Mechanical Engineer of the Lehigh Valley Railroad.

The important facts regarding circulation in steam boilers, as viewed by "Engineering News," are summed up in a recent issue of that journal as follows: "Circulation in a boiler is of value, and should always be secured to a sufficient extent to keep the heating surface bathed in water and to prevent their undue heating and the injury of the boiler through unequal expansion. The more rapid the circulation, the better will this end be attained; and some gain is also to be secured through the reduced tendency of sediment to deposit on the heating surface. It is in these directions and not in any increased evaporative efficiency that the gain from good circulation is to be found. While in theory rapid circulation should very slightly improve the economy of a boiler, the gain is too slight to be discernible by any practical tests."

STEAM GAUGES.

Tests and Method of Connecting.

Wide and even dangerous variation in the readings of ordinary locomotive steam gauges have been found on a prominent railroad as a result of a series of tests or comparisons of gauges which have now been carried on systematically for over two years. The gauges are removed from the engines and readings are taken at intervals of 10 pounds ascending and descending the scale, the comparisons being made by weighted piston apparatus. The records of the tests are made on sheets of cross section paper and preserved until some of the charts now show eight or nine records of the same gauge taken at sufficient intervals to indicate the character and extent of variations that are caused by ordinary service conditions on the locomotives. Many of the lines are very crooked and some show errors of 15 pounds at the blowing off pressure, while others show an error of as much as 60 pounds at pressures below 100 pounds. The curves include all of the well known makes of gauges and as a rule they all vary least from the correct pressure at the blowing off point. The errors are sufficient in extent and abundance to force the conclusion that gauges ought to be followed up carefully entirely aside from the consideration of safety, because of the important influence of steam pressure upon the economical working of locomotives. These tests at once form a basis for comparison of the merits of the work of the various makers and as the differences in reliability are marked a test of six gauges by different makers is now being conducted in a way that permits of securing uniform conditions for all. The gauges are mounted in a frame on a road locomotive and fixed to the cab wall, out of the way of the men. They all receive steam from the pipe that supplies the engine gauge, and steam can not be shut off from them without shutting off his working gauge also. The faces of the six gauges are blanked by sheet iron discs, and after testing them they are to run until the comparisons are complete, frequent readings being recorded.

One result of this investigation is to show weak spots in arrangement and in construction used by certain of the manufacturers, which have already been the means for improvement. It has been shown that the method of piping the steam to a gauge is more important than has been considered, and that it is necessary to use siphons of rather large capacity in order to guard against the entrance of steam into the gauge spring, an occurrence that seems to be possible owing to the expansion of the spring, if the siphon is too short. The gauges on the road referred to are now fitted with the usual siphons at the gauge connection, and instead of carrying the copper tube to the boiler direct it is given two turns around the back of the gauge. This long tube is filled with water, and besides adding to the volume of the contents of the siphon, it tends to keep the temperature of the gauge spring more uniform. Its effect appears to be to render the actions of a gauge more uniform and reliable.

Prof. Ripper says that the importance is admitted of maintaining a column of water in the syphon of the pressure gauge to keep the gauge cool, so that its readings may be consistent, and so as not to subject the gauge to high or variable temperatures. It is generally supposed that if the gauge has a syphon there is always water in it, and that when the syphon is once full of water the water is easily retained therein, but these assumptions are not warranted by the facts. The water will disappear from the syphon from various causes. If there is the smallest leak in the gauge end of the syphon, then the water is all gone in a minute or two by being blown out by the steam, though the leak may be almost imperceptible. If the pressure to which the gauge is subjected is a variable one, the water will disappear from the syphon as usually constructed in a few minutes, especially on a sudden reduction of pressure in the same way that water in the engine cylinder disappears during expansion and exhaust."

MECHANICAL STOKERS.

Why They Sometimes Fail.

In a discussion of the subject of combustion in stationary boiler furnaces and mechanical devices for firing them, Mr. W. E. Snyder offered the following conclusions before the Engineers Society of Western Pennsylvania:

1st. The phenomena of combustion are governed by certain laws which must be obeyed if good results are to be obtained.

2d. The test of the action of any boiler furnace is the character of its products, solid and gaseous.

3d. It is not possible to work the common grate as used in the ordinary manufacturing plant in accordance with the laws of combustion.

4th. Devices which are used as auxiliaries to common grates may, under favorable conditions, be beneficial, but usually simply complicate matters without compensating for the disadvantages of the common grate.

5th. Mechanical stokers should effect a saving over common grates, but in some cases this saving may be neutralized by certain losses co-existent with the operation of the stoker.

6th. The failure of mechanical stokers to produce satisfactory results is probably due more frequently to inattention on the part of superintendents, carelessness on the part of the men who operate them, or a dense ignorance of the entire subject of combustion on the part of all concerned, than it is to actual defects in the principle or action of the machine itself.

A cause of increased flange wear on car wheels was given by a correspondent of the "Railroad Gazette," as arising from the shallowness of the chill in the throat of the wheels. According to this correspondent it is only in the last few years that this increase in the wear of flanges has been noticeable. The iron used in earlier days, which was soft gray iron, with coarse granular fracture, was far more sensitive to chill and made an ideal car wheel metal. It was rich in carbon and poor in all other elements and would take a chill almost as deep in the throat as on the tread. But such iron cannot be obtained now for making wheels. It is possible to obtain the same depth of chill with the iron used in making wheels at the present time, but it is done at the expense of the softness and ductility of the gray portion of the wheel. It, therefore, seems necessary with the irons used at present, to reduce the chilling qualities of the metal in order to meet the "thermal test." And while the depth of chill upon the tread of the wheel is sufficient to withstand long wear, the chill in the throat is often deficient.

The sand blast has been used with marked success in cleaning the iron lock gates of the Muscle Shoals Canal on the Tennessee River. The report of Major Kingman, of the Corps of Engineers, U. S. A., describes the apparatus used. It was placed under a roof on a barge and consisted of a 12 by 14 inch stationary engine and a pair of 9 by 9 inch Clayton direct coupled air compressors. The air was compressed into several receivers from the last of which three blast pipes were carried to the sand drums, the blast being controlled by valves. Each blast pipe terminates in a piece of hose about 25 feet long with a ⅜-inch tool steel nozzle at the end. There are two 18 inch sand drums 4 feet long for each blast pipe. These are in duplicate so that one may be filled while the other is in use and the work be carried on continuously. The drums are filled from a large hopper extending over all of them. Into this the sand is put after screening and drying. A ½-inch pipe admits air pressure to the top of each drum. Records for the year ending June 30, 1898, showed that for a total of 44,522 square feet of iron work cleaned and painted the cost was but 2.3 cents per square foot.

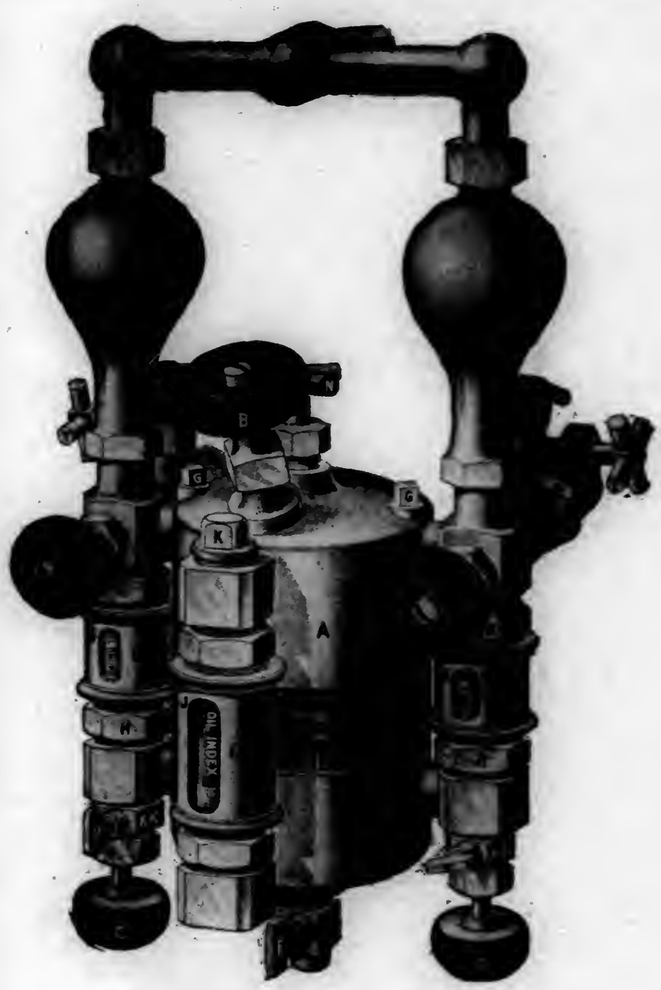
A METHOD OF BENDING PIPE.

The bending of pipes of relatively large diameter without distortion or weakening is a rather difficult process and with the large number of arch tubes in use in locomotive fireboxes this work is often necessary in locomotive shops. If pipes could be bent without difficulty probably advantage would often be taken of easy bends, instead of using the abrupt turns involved in standard fittings. Formers may be used for pipes of small diameters, but for those requiring heating the following practical suggestions offered by Mr. R. H. Perry, in "Machinery" will be found useful:

The most practical method under such circumstances is to fill the pipe to be bent with perfectly dry sand and plug or cap the ends so that the filling will be retained under quite severe handling. Care should be taken to have the pipe well filled with the sand and that there is nothing inflammable or damp in it, as the necessary heating of large pipes is very likely to cause a serious explosion. The heating of the pipe may be done in an ordinary forge, and should be restricted to the part of the pipe that is required for the bend; also overheating should be avoided, as the loss from scaling has a very appreciable effect on the bursting strength. The best results will be obtained when the heat is not carried above a dull red, as the liability to kinking is less, and in any case it is usually necessary to heat two or three times before a sharp bend can be satisfactorily made, so that nothing is gained by heating to a high temperature. A can of water should be provided, which should have a spout so that a small stream can be directed exactly where needed, as its proper use plays an important part in securing bends without kinks, a point which is highly desirable, as a kink is always an eyesore in the appearance of a pipe, besides seriously reducing its capacity at that point.

After the pipe has been heated to the proper temperature, it is clamped in the vise as close to the location of the bend as possible without grasping the red hot part and the bend started, but first the outside of the curve should be cooled with water carefully applied from the can. The inside of the bend being hot and plastic is compressed as the bend is made with very little tendency towards flattening, but if such a tendency develops, it can be corrected by loosening the pipe and using the jaws of the vise to bring the flattened part back to an approximately circular section. The reason for applying the water to the outside of the curve is that by forcing the bend to take place on the inside of the curve, the pipe walls are better supported by the filling, for the reason that the cubic contents are slightly reduced by the compression; whereas if the exterior of the curve be allowed to stretch, the cubic contents are slightly increased, which allows a small amount of slackness in the filling at that point and a consequent lack of support to the interior of the pipe. The use of water also plays an important part in the proper formation of the curve, as by its use the pipe may be cooled at a point where the required curvature has been obtained and still leave the remainder in a condition to be bent as desired. When bending pipe without formers it is necessary to have a template, which may be made from a ¼-inch rod bent to the desired curve and which, being laid on the pipe while bending, gives a guide for the operator. The use of water for cooling the outside of the curve can usually be dispensed with when the radius equals or exceeds fifteen times the diameter of the pipe.

Most expensive mistakes in the construction of the Siberian Railroad are reported by R. T. Greener, Commercial Agent of the United States at Vladivostok. He states that the rails on both the Siberian and the Trans-Baikal lines are too light and that many of the cheap wooden bridges are failing. The result is that speeds are reduced to 20 miles an hour. From this report the location seems to have been faulty and the general condition of the road very bad. Apparently not less than $7,725,000 will be required to put the Trans-Baikal line in running order, and the whole Siberian road will require $25,750,000, so much of the work must be done over again.



Powell's Locomotive Lubricator.

POWELL'S LOCOMOTIVE LUBRICATOR.

The accompanying engraving illustrates a sight-feed lubricator for locomotives, known as Powell's "Star" duplex condenser lubricator. It has a double up-feed and is a radical departure from former styles of single condenser cups, and overcomes the difficulty of "cross feeding" on syphoning the oil wastefully from the lubricator to one of the cylinders at the expense of the other cylinder. This results in too much lubrication in one cylinder and too little in the other, and it is specially likely to occur when the engine is drifting with steam shut off. In this lubricator each cylinder delivery pipe has a separate and independent condenser, also a separate steam pipe, which renders the lubricator action for the cylinders entirely independent. An advantage is also believed to be obtained by a special water and oil trap in connection with the customary water tube leading to the bottom of the oil chamber. Its effect is to insure a positive supply of water and a uniform feed of the oil. A convenient feature of this lubricator is the arrangement of the valves. The adjustment of the feed is secured by means of the lower feed valves, C C, and once adjusted for the desired rate of feeding they need not be disturbed, because the lubricator is put into and out of operation by means of the ejector valves, D D. The body and all arms projecting from it are cast in a single piece, and the fittings are not screwed into the main casting. In this way a number of joints are avoided. Our engraving shows the location of the filling valve, B, the water valve, N, the oil index, and other parts. These lubricators are manufactured by the Wm. Powell Company, 2525 Spring Grove Avenue, Cincinnati, Ohio. This company also makes triple-sight feed lubricators.

PERSONALS.

Mr. George H. Hancock has been appointed Superintendent of Machinery of the St. Louis & San Francisco, with headquarters at Springfield, Mo., vice J. R. Groves, resigned.

Mr. Charles P. Savage has been appointed Purchasing Agent of the Erie & Wyoming Railway, also for the Pennsylvania Coal Company and the Dunmore Iron and Steel Company, with headquarters at Dunmore, Pa.

Mr. J. J. Thomas, Jr., Master Mechanic of the Tuscaloosa shops of the Mobile & Ohio, has been made Assistant to the Superintendent of Motive Power and Car Equipment, with headquarters at Mobile, Ala.

Mr. H. D. Norris has been appointed Acting Purchasing Agent of the Pere Marquette, with headquarters at Grand Rapids and Saginaw, Mich., in place of Mr. R. Wallace, resigned. In addition to his duties as Purchasing Agent he will have charge of the company's stores.

Mr. H. M. Carson, formerly Assistant Engineer of Motive Power of the Pennsylvania Railroad at Altoona, Pa., has been appointed Master Mechanic, with headquarters at Pittsburg, vice Mr. D. O. Shaver. Mr. Carson is one of the ablest and most promising of the younger men of the mechanical department of the Pennsylvania.

Mr. W. H. Marshall, Superintendent of Motive Power of the Lake Shore & Michigan Southern, has also been appointed Superintendent of Motive Power of the Lake Erie & Western, vice Mr. P. Reilly, resigned. Mr. Marshall will undoubtedly apply to this road the same methods of dealing with motive power questions that he has so successfully applied on the Lake Shore.

It is reported that Mr. T. S. Lloyd, Master Mechanic of the Chesapeake & Ohio, will succeed Mr. J. W. Fitzgibbon as Superintendent of Motive Power of the Delaware, Lackawanna & Western. Mr. Lloyd is 47 years old, and has been Master Mechanic of the Clifton Forge shops of the Chesapeake & Ohio, also the shops at Richmond, Va., since 1890, previous to which he held a like position on the Cincinnati Division. He has also been identified with the Erie and Pennsylvania railroads.

The following changes in the mechanical department of the Baltimore & Ohio are effective March 1st, 1900: The position of Master Mechanic at Grafton is abolished. Mr. P. Hayden is appointed General Foreman at Benwood, vice J. F. Prendergast, transferred. Mr. J. F. Prendergast is appointed General Foreman at Grafton, W. Va., vice P. Hayden. Mr. P. J. Harrigan is appointed General Foreman at Connellsville, Pa., vice D. Witherspoon, who has been appointed General Foreman at Cumberland, Md.

Addison C. Rand, President of the Rand Drill Company, who died recently at his home in New York City, was born in Westfield, Mass. Mr. Rand was a pioneer in the manufacture of steam drills and air-compressing plants, and had been one of the foremost in building up the great business of his house. He was one of the founders, and for some time Treasurer, of the Engineers' Club of New York City. He was also a member of the American Institute of Mining Engineers, and of the American Society of Civil Engineers.

Mr. Fayette S. Curtis, for 12 years Chief Engineer of the New York, New Haven & Hartford, has been elected Fourth Vice-President of that road. Mr. Curtis was born in Owego, N. Y., December 16, 1843, and was educated in the Owego Academy, taking a special course in civil engineering. After graduating in 1863 he was employed for eight years in the location and construction of various railroads. In 1871 he was employed by the Harlem River & Portchester Railroad in the location of a line between New Rochelle and the Harlem River. In 1874 he was appointed Chief Engineer of the New York & Harlem Railroad Company, continuing in this capacity until 1883, when he was appointed Chief Engineer of the New York, New Haven & Hartford.

John M. Holt, who has been for a number of years General Foreman of Car Repairs of the Southern Railway, died suddenly at Washington, D. C., February 25. Mr. Holt began his railroad career in 1865 as an apprentice in the car department of the Burlington shops of the old North Carolina Railroad, and when this road was absorbed by the Richmond & Danville he was transferred to the Manchester shops as Foreman of Car Repairs. Soon after the Richmond & Danville was incorporated in the Southern Railway he was appointed General Foreman of Car Repairs at Washington, D. C. Mr. Holt was a very able and successful man in his particular line of business, and commanded a reputation for fairness which made him well liked by all who knew him. He was an active member of the Master Car Builders' Association.

Charles H. Coster, whose recent death was so keenly felt, not only by the many prominent railroads of which he was a director, but by the corporate interests of this country, was born at Newport, R. I., July 24, 1852. He began his business career with a firm of importers in 1867. In the course of his business career his work has always been concerned with the larger commercial interests of the City of New York. He became a partner in the banking house of Drexel, Morgan & Co. in 1884 and was at the time of his death a partner in J. P. Morgan & Co., Drexel & Co., Morgan, Harjes & Co., and also a director of 46 of the most prominent railroads of this country. Several of the boards of directors of which he was a member, feeling the loss of so successful and upright a man, have placed on record their realization of the fact by appropriate resolutions. This is unusual, and is a high tribute to his memory.

BOOKS AND PAMPHLETS.

Interaction of Wheel and Rail. Translated from the German of Boedecker by A. Bewley, Public Works Department, India.

This work gives in three chapters a theoretical discussion of the relations between the wheels of railroad trains and the rails. It is a difficult mathematical subject, and the translator has been careful and thorough. The first chapter deals with the motion of single axles, the pressure and surface of contact of wheels and rails, and the friction of rolling. The second takes up the motion of four-wheel cars on curves and the third covers the same ground with locomotives having three pairs of wheels.

Nickel-Steel: A Synopsis of Experiment and Opinion. By David H. Browne, Cleveland, O., Head Chemist for the Canadian Copper Co. A paper presented to the American Institute of Mining Engineers at its California meeting, September, 1899.

This pamphlet of 80 pages contains the paper by Mr. Browne in advance of its publication in the transactions of the Institute. It is the most valuable treatment of the subject of nickel-steel that has ever appeared; in fact, it is a classic. Everyone who is interested in the design, construction or operation of machinery, and especially where strength, weight and ability to withstand repeated stresses are concerned, should procure a copy for study and reference.

Handbook and Illustrated Catalogue of Engineers' and Surveyors' Instruments of Precision. C. L. Berger & Sons, Boston, Mass.

This catalogue, 6 in. x 9 in., of 212 pages, including index, is bound in stiff boards and contains descriptions and illustrations of the latest styles and important improvements in the various instruments used by engineers and surveyors. Some of the more recent improvements which are illustrated in this catalogue are: A bracket by means of which the transit may be set up in narrow places, as in shafts of mines, where it is impossible to use an extension tripod; a short focus lens attachment which will admit of objects being focused at distances as close as three feet from the instrument, and many minor attachments and improvements for field instruments

used in astronomical observations. There are also given in this volume several chapters of valuable information concerning the care and adjustment of instruments.

Report of Tests Made by Prof. W. F. M. Goss on a Vertical Triple Expansion Crank and Fly Wheel Pumping Engine, Having a Daily Capacity of 20,000,000 Gallons.

A record of 167.8 million foot-pounds of work per 1,000 pounds of dry steam, as was shown by the Snow Pumping Engine at Indianapolis, Ind., in a duty test made by Prof. W. F. M. Goss, Purdue University, in 1898, has awakened the highest interest among engineers and users of pumping engines in this country as well as abroad. For those interested in pumping machinery the two complete tests made on this engine, one in July, 1898, and the second in December of the same year, have been printed and put in pamphlet form. We are indebted to Prof. Goss for a copy of these valuable and interesting reports, which are the best specimens of pumping engine testing of which we have record. There is also given in this pamphlet, by Mr. G. H. Barrus, M. E., Boston, Mass., a comparison of the performance of this engine with a number of other prominent engines which have been tested within the last six years.

Handbook of Testing Materials for the Constructor. By Prof. Adolf Martens, Director of the Royal Testing Laboratories at Berlin and at Charlottenburg. Translated by Gus. C. Henning, M. Am. Soc. M. E. 2 vols., cloth, 6 by 9 inches, 622 pages; illustrated. New York, 1899: John Wiley & Sons. Price of two vols., $7.50.

The author's preface states the object of the work as follows:

My book on Testing Materials for the Constructor is designed to be a counsellor to the constructor in all questions relating to the properties of his materials of construction. Therefore the book is divided into two volumes, each independent and complete in itself. This first volume relates to the general properties of materials of construction, and especially to the art and science of testing materials as applied to machinery and superstructure. To the description of the customary methods of testing I have added a presentation and discussion of the most important types of testing machines and auxiliary apparatus, dwelling mainly upon the underlying principles of design, sources of errors, and on their calibration. As this volume contains the manifold experiences of the laboratories under my direction, and as I have availed myself of the liberal arrangements granted by the publishers to fully illustrate, by figures and plates, the most important machines and instruments of all countries, I hope to produce a lasting benefit, not alone to my students, but also to manufacturers of apparatus, by my frank and candid criticism.

The translator states in his preface that he has faithfully followed the author and reproduced his thought in the hope of promoting greater uniformity in testing and more accurate knowledge of materials. He has done his work carefully and should be credited with giving readers of English a most excellent treatise on this subject which was not available in the language before. The separation of the engravings from the text and binding them in a separate volume seems, at first, very awkward, but it is really not so, particularly in the use of descriptions covering several pages and referring to a single engraving or group of engravings.

This work gives more information about testing, testing machines and incidentally about materials, than any book we have seen. We commend it to our readers who have to do with the testing of materials.

Steam Engine Theory and Practice. By William Ripper, University College, Sheffield, England. Published by Longmans, Green & Company, New York, 1899. 389 pages; illustrated. Price $2.50.

This modest work of scarcely 400 pages essays to comprehend the whole field of steam engine theory and practice. The purpose is an ambitious one, but the text is so very concise that the reader soon begins to wonder at the great degree of thoroughness which is secured in so limited a space. Mathematical expressions are not prominent, though the development of the usual thermodynamic relations are all presented, but in such good form and so intermingled with the descriptive matter as to relieve the book of that formidable appearance which often characterizes works upon similar subjects. Graphical presentations are numerous and interesting. The chapter on temperature-entropy diagrams, with a large plate by Captain Sankey, is of especial interest, and another on superheated steam, dealing with a subject which just now is much alive in England and on the Continent, is full and altogether satisfactory.

While the book is written by an Englishman and primarily for English students, it contains frequent references to American practice. For example, both the Carpenter and Peabody calorimeters are described; the John Fritz fly wheel is illustrated; the experiments on engine friction by Dr. Thurston are referred to, and the results of locomotive tests by Prof. Goss are discussed. The author's preface contains the following:

Special attention has been given to the subject of heat quantities involved in the generation and use of steam. For this purpose the temperature-entropy diagram has been used, and its applications in the solution of a number of ordinary every-day problems exemplified. The writer desires to express his personal indebtedness to Captain Sankey for his kindness in supplying him with copies of his temperature-entropy chart, which appears for the first time, as Plate I. of this book. This chart has gone through an interesting process of evolution since the occasion when Mr. J. Macfarlane Gray read his paper at the Paris meeting of the Institution of Mechanical Engineers in July 1889, on the "Rationalization of Regnault's Steam Experiments," describing and explaining the use of the steam and water lines of the temperature-entropy chart. Since that time Capt. Sankey has added lines of constant pressure, and constant volume in 1892; and more recently also the scales of total heat and internal energy, as well as the chart for the superheated steam field. All these additions now appear upon the chart as shown in this book.

The Steam Engine and Gas and Oil Engines. A book for the use of students who have time to make experiments and calculations. By John Perry, D. Sc., F. R. S., Professor of Mechanics and Mathematics, Royal College of Science. Published by The Macmillan Company, 66 Fifth Avenue, New York, 1899: Price, $3.25.

The plan of this excellent book contemplates a large amount of verification of the author's presentation by the student. It aims to induce the reader to investigate and work out problems for himself. The study by mere reading is discouraged and the student is urged to test the laws given by the philosophers. The portion devoted to the steam engine is one of the best treatments of the subject ever written, because it tends to stimulate thought and study rather than to assume an acceptance of what one is told by others. It is essentially devoted to the steam engine. The book is strong in its adherence to practical conditions of actual modern experience, and the considerations of questions which occur in the eyery day work of engineers. It is not a mathematical discussion. The author gives the first place in importance to the facts of experiment. He then brings mathematics to bear in accounting for and using them in study and design. The sensible use of simple mathematics is one of the striking features of the work. A large amount of space is given to the form instruction and arrangement of the detail of steam engines. The illustrations are better than those usually found in English works of this kind. The author, however, hesitated to describe "the old despised type of engine." It is not only the easiest to describe but the most important for the student to understand. The study of details and thermodynamics are combined as they have not been before. There is a good chapter on valve gears, one on balancing or governors, a satisfactory study of boilers and combustion.

It is essentially a book for students, but as the practicing engineer never ceases to be a student, it will be of great value to him. It contains a new analysis of the performance of the Willans engine. Its only serious fault is the omission of credit for the borrowings from the work of others.

"Centrifugal Ventilators," is the title of a pamphlet by J. T. Beard, presenting a mathematical study of the centrifugal fan with particular reference to its use for the ventilation of mines. It is published by The Colliery Engineer Co.

"Packings" and "Garden Hose" are the titles of two little pamphlets received from the Boston Belting Co., 256 Devonshire St., Boston, Mass. These present illustrations and printed descriptions of the many varieties of these products as manufactured by this well-known concern. They also contain the accessories, such as valves, wire rope sheave fillings, gage glass packings and the fittings for various kinds of rubber hose.

Coal Washing Machinery.—The Jeffrey Manufacturing Co. of Columbus, O., has issued a profusely illustrated pamphlet of 88 pages as a catalogue of coal washing and coal handling machinery. This company has developed a coal washing system with a view of placing before coal operators a comparatively low cost plant which will enable them to market the low grades of coal and greatly improve the quality of higher grades. The pamphlet presents a large number of engravings of plants in use giving photographs and line drawings. It also contains a reprint of a paper by J. J. Ormsbee, read before the American

Institute of Mining Engineers, in which the coal washing plant at No. 2 Slope, Pratt Mines, Alabama, is described. The results of the washing are given in detail, one of which was to reduce the amount of ash in the coal from 9.98 to 5.78 per cent. This paper is an interesting report on the washing of coal and is very satisfactory and complete. In addition to coal washing machinery, attention is given to retarding conveyors, steam coal tipples and the coal elevating and conveying machinery, in connection with which this company has become so well known.

"Our Railroads and Our Canals" is the title of an 18-page pamphlet containing a reprint of an address by Mr. George H. Daniels, General Passenger Agent of the New York Central Railroad, before the Chamber of Commerce of Utica, N. Y., February 19, 1900. It has been placed in the "Four Track Series" and presents a strong argument in favor of the railroads by showing that canal transportation has outlived its usefulness on account of the modern development of railroads. The closing paragraph of the address expressed the speaker's position in the following words:

The day of the canal packet and the stage coach has gone by, never to return, notwithstanding the fact that in their day and generation they were of great value to the country; but a newer and better means has been found, more in keeping with the advancement of our people in all the arts and sciences; and if the American people will treat the railways with the same degree of justice that in the past they have treated their canals, our commerce will continue to expand, until we stand at the head of the commercial nations of the world.

It is understood that Messrs. W. H. Patterson and A. C. and D. W. McCord have secured control of the Illinois Car & Equipment Co. The English capital is still retained, but American interests have been added and hereafter the company is to be managed solely in this country. Mr. Patterson and Mr. A. C. McCord have recently returned from England, where the arrangements were consummated. The report that McCord & Company were to assume charge of the car company is erroneous and arose probably out of the fact that the officers of the two companies are practically identical. A working arrangement between the two companies has been effected whereby a part or all of the specialties of McCord & Company will be manufactured at the works of the car company. Various extensions and improvements in the plant are being made. For the present the work is to be confined to the construction of wooden cars, forgings and castings. Mr. L. Oberauer is retained as superintendent and Mr. D. L. Markle as assistant manager.

EQUIPMENT AND MANUFACTURING NOTES.

The number of students now enrolled in the International Correspondence Schools is 160,000, and it is constantly increasing.

The Navy Department has placed an order with the New York Air Compressor Company, 120 Liberty Street, New York, for two duplex compound air compressors of large capacity for the Charlestown Navy Yard, Boston, Mass.

The Robert Aitchison Perforated Metal Co., of Chicago, have moved their offices from 269 Dearborn Street to the Plymouth Building, 303 Dearborn Street, of that city. Their new quarters are much larger, more comfortable and more suitable than the former ones.

The "Consolidated Railway Electric Lighting & Equipment Co." is the name of the organization under which the American Railway Electric Light Co., the United Electric Co., the Columbian Electric Car Lighting and Brake Co., the Electric Axle Light and Power Co. and the European Railway Electric Lighting Co. have been amalgamated.

The Union Boiler Tube Cleaner Company of Pittsburg have issued circulars illustrating their very effective devices for cleaning the tubes of water-tube boilers, and giving records of tests of boilers of the Standard Oil Company, showing a saving of 24.8 per cent. in fuel as a result of cleaning tubes at their works. The construction and operation of the cleaning devices are described by aid of engravings made from photographs of actual work. The cleaning devices are adapted to curved as well as straight tubes.

A continuous exhibition of machinery and manufactures in New York City has been provided for by the International Land and Exhibition Co. in the Bowling Green Office Building. The object is to extend to every manufacturer the privilege of an office in New York, together with a show room for machinery in motion and in charge of experienced engineers and competent salesmen. The moderate rate of $6 per square foot per year is charged for the space and a number of important industries have already availed themselves of the opportunity. The plan is a large one, including representation in foreign countries. Mr. Albert Krimmert, President of the International Land and Exhibition Co., Bowling Green Offices, New York, should be addressed for further information.

The Ajax Metal Company have been conducting elaborate laboratory tests of bearing metals as a result of a series of experiments made upon the wearing qualities of bearing metals by officers of the Pennsylvania Railroad. Among other things these tests brought out the desirability of reducing the proportion of tin and increasing that of lead in the bearings up to a point where homogeneity was sacrificed. The Ajax people have been successful in this direction to the extent of reducing the proportion of tin from 8 to 5 per cent., and increasing the proportion of lead from 15 to 30 per cent., without sacrificing homogeneity. When compared with phosphor-bronze these proportions of tin and lead gave less than one-third of the wear and 20 per cent less rise in temperature from friction.

Mr. J. W. Lowell has been appointed manager of the railroad department of the Manhattan Rubber Manufacturing Co., of 18 Vesey St., New York. He has been connected with the mechanical department of the Pennsylvania Railroad for eight years, two years as draftsman and six years in the test department. This company has decided upon an increased activity in the manufacture and sale of air brake hose and mechanical rubber specialties for the railroads. Mr. Lowell will be a valuable addition to the staff because of his practical railroad experience and technical education. He learned the machinist's trade in the shops of the Baltimore & Ohio R. R. at Baltimore and afterward served on the civil engineering staff of the Baltimore Belt line. Before entering the service of the Pennsylvania he was connected with the engineering department of the Maryland Steel Co. at Sparrows Point.

The product known as Warren's Liquid Pulley Cover has created considerable interest and we are asked what it is. It is not a belt dressing, but a pulley paint for which the claim is made that it will prevent belts from slipping and retain its effectiveness for years. It is made by the Warren Manufacturing Co., 36 Jackson Street, Chicago. Its object is to furnish to a smooth wood or iron pulley a surface which has a natural affinity for the belt. It is accomplished by painting the face of the pulley with a liquid which may be applied with a brush and will become dry in about two hours. The manufacturers have so much confidence in the qualities of this material as a preventive of the slipping of belts that they are willing to send it on trial. A pulley cover which will do away with the danger, expense and annoyance of slipping belts must prove advantageous in every establishment where belts are used. Attempts to prevent slipping usually take the form of excessive tightening and, assuming that sufficient adhesion is obtained in this way, the excessive strain on the belt must increase the friction on the bearings and the expense of lubrication. It not only adds to the loss of power, but tends to throw the shafting out of line and greatly decreases the life of the belts. If the adhesion, under the increased tension, is still insufficient to prevent slipping, heat is generated even with a very slight amount of slip, and the belt loses its natural oil and its life will be short. Cases of fire have been known to arise from this source, an instance having recently occurred at the works of the American Steel & Wire Co., at Waukegan, Ill., in which the loss was heavy. Furthermore a belt which slips is a constant source of loss of power. The manufacturers are very careful to state that this is not a sticky preparation which requires work to be done to make the belt and pulley separate as the pulley revolves. If this liquid pulley cover is all that is claimed for it by users, it is an admirable substitute for the leather lagging which has been used extensively in a great many kinds of machinery. The Warren Manufacturing Co. will furnish complete information concerning this product, which is rapidly taking a place among the staple supplies of the important manufacturing establishments throughout the country

AMERICAN
ENGINEER
AND
RAILROAD JOURNAL.

MAY, 1900.

CONTENTS.

80,000 AND 85,000-POUND COAL CARS.

Buffalo, Rochester & Pittsburgh Railway.

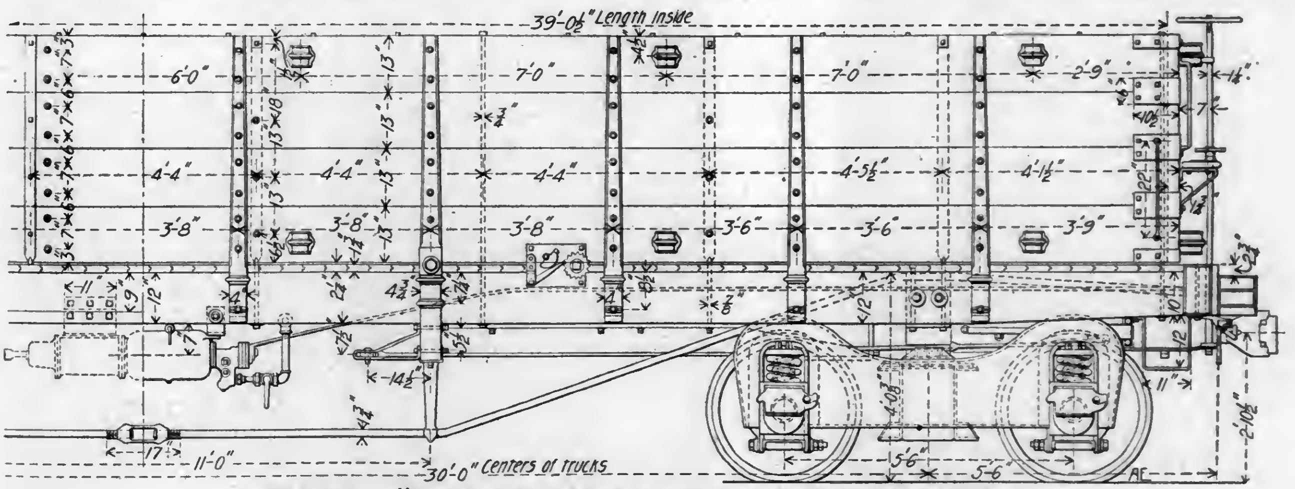
Several designs of wooden cars of large capacity for carrying coal and coke have been made by Mr. C. E. Turner, Superintendent of Motive Power of the Buffalo, Rochester & Pittsburg Railway, and we have received the drawings of two of the coal cars. These cars are for widely different purposes, the treatment being far different in the two cases. The 80,000-pound car is for use in transporting coal for unloading at station team tracks, and is designated a "shovel car" because it is low sided for convenience in unloading by hand when the drop doors cannot be used. The 85,000-pound car is for use in dock and trestle service and is called a "dock car." Both were designed to fit the clearances of the road, which are limited by sheds and other obstructions, the problem being to secure the necessary volume by keeping within the necessary limits of height and length. The length is limited by sharp curves. The height from the top of the rail to the under faces of the sills at the ends is unusually low, being but 30 inches in the dock car and 30½ inches in the shovel car, when measured at the ends. This height is usually more than 36 inches. The chief dimensions of the two designs are indicated in the following table:

General Dimensions.

	Hopper car.	Shovel cars
Length over end sills	32 ft. 6 in.	41 ft. 0 in.
Length inside of box	30 ft. 6 in.	39 ft. ½ in.
Width over side sills	9 ft. 3 in.	9 ft 0 in.
Width inside of box	8 ft. 5 in.	8 ft. 5½ in.
Height rail to top of box	9 ft. 1⅛ in.	8 ft. 6 in.
Height over all	9 ft. 6 in.	8 ft. 11¼ in.
Height to bottom of sills	30 in.	30½ in.
Height of box inside	5 ft. 0 in.	52⅝ in.
Door openings, length	3 ft.	4 ft. 4 in.
Door openings, width	3 ft. ⅝ in.	17 in.

The shovel cars were developed from gondolas, without the doors, these having been added afterward. There are four 1¾-inch truss rods with the ends upset to 2 inches. The trusses are 36½ inches deep, measured from the center of the rod at its lowest point to the center at the highest point. The lower line of the truss rods is but 10 inches above the rail. The bolsters are of plate construction, with malleable-iron filling pieces, and the depth of the truss is 19¼ inches. The side sills are 5 by 12 inches, and the four intermediate sills are 5 by 9 inches. The draft timbers are reinforced by 4-inch sub-sills, which are continuous. The draft gear is the Butler type, and the draft timbers may be taken down without removing the bolsters. The siding stakes are tapered to save weight, and, as will be seen in the side elevation of this car, stake pockets are provided for use in loading lumber. The greatest variety of uses was kept in mind in this design, and it was intended to make the car convenient in the iron ore, lumber and bark trades as well as for hauling coal, and in the coal trade the cars are unloaded either through the doors or over the sides. This car has Fox pressed steel trucks.

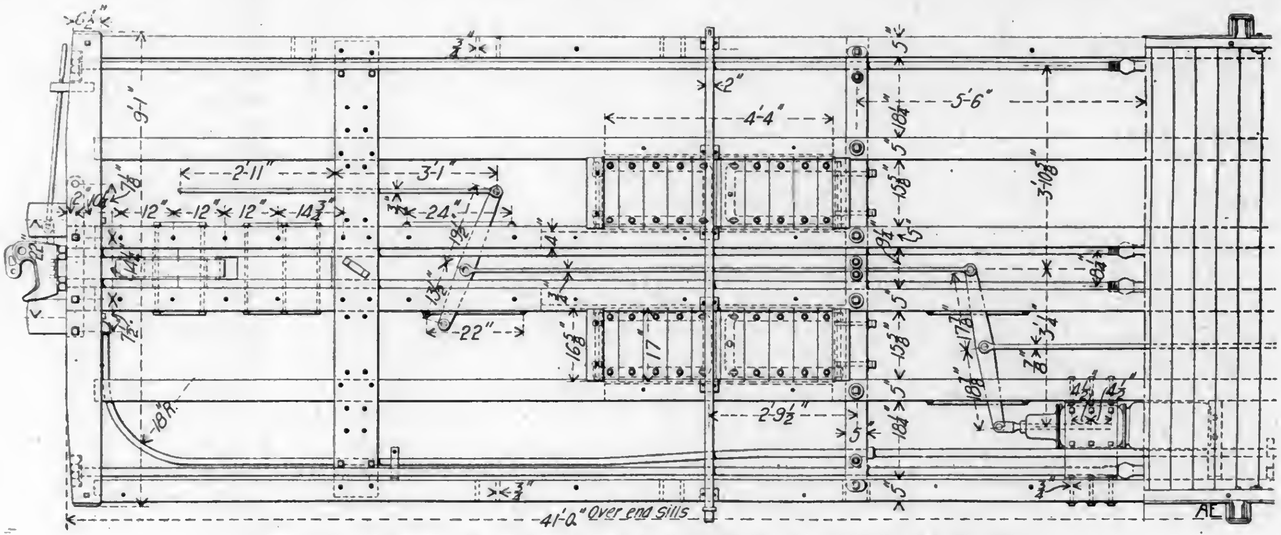
The dock car is of the gondola type, with a single shallow hopper extending 24 inches below the floor line. It has four 1½-inch truss rods arranged in a truss that is 35 inches deep, measured from the offset in the truss rods. This is a short car for its capacity. The sides are high, however, and the body is low, which accounts for its large capacity within the limits imposed. This car is a development of a former design for 80,000 pounds capacity, which was 28 feet 6 inches long inside. The increased capacity was obtained by adding 2 feet to the length. About 1,000 of these cars are now running in the coal and ore trades. They haul coal in one direction and return loaded with ore. One of them has been loaded with 132,000 pounds of iron without running hot on bringing the side bearings into contact. The arrangement of sills and other floor timbers is clearly indicated in the engravings.



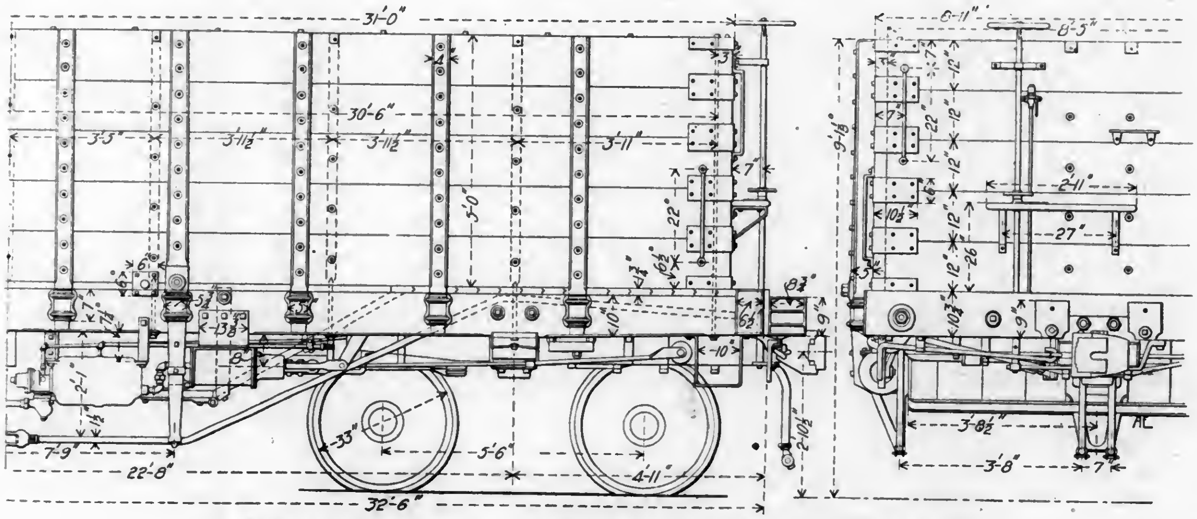
80,000-Lb. "Shovel Car"–Buffalo, Rochester & Pittsburgh Railway.

Half Side Elevation.

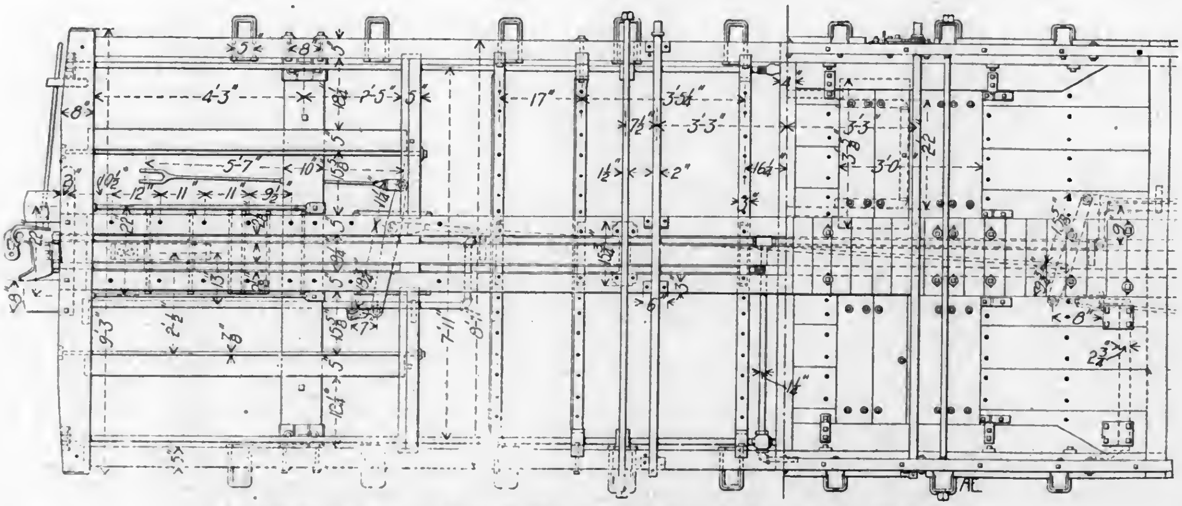
In these cars a great deal of attention has been paid to



80,000-Lb. "Shovel Car"—Buffalo, Rochester & Pittsburgh Railway.
Plan of Floor System.



85,000-Lb. "Dock Car"—Buffalo, Rochester & Pittsburgh Railway.
Half Side Elevation and Half End Elevation.

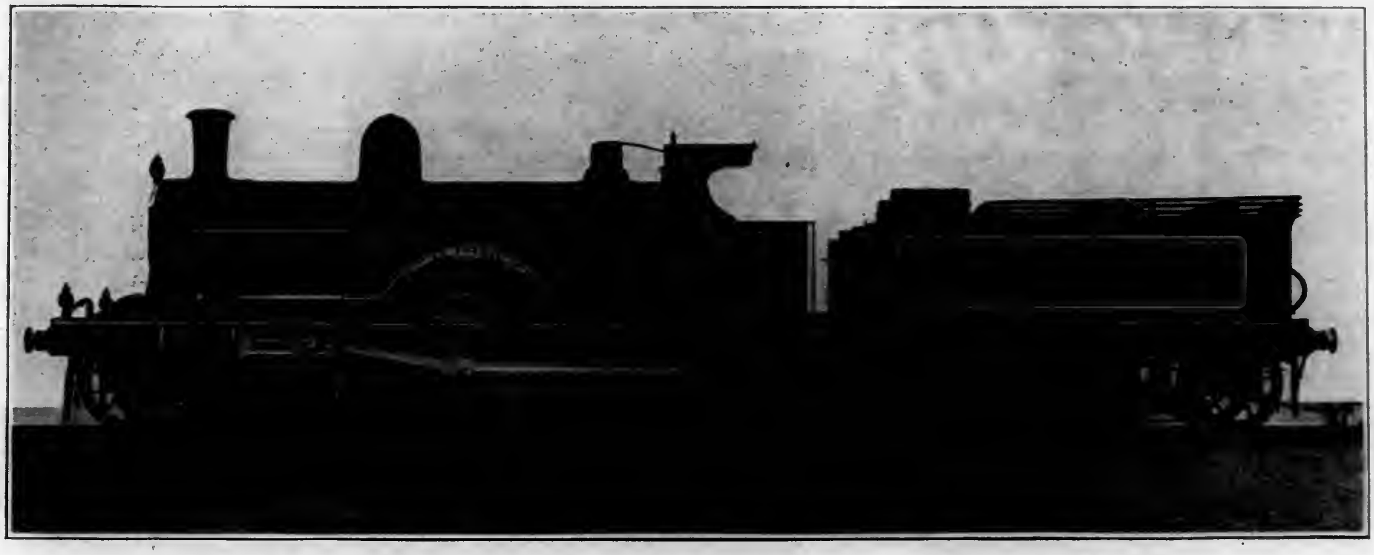


85,000-Lb. "Dock Car"—Buffalo, Rochester & Pittsburgh Railway.
Half Plan of Floor System.

malleable castings with a view of obtaining the complete benefits from light weight which they offer. The elastic limit of malleable iron was taken at 30,000 pounds per square inch, and the ultimate strength at 40,000 pounds, the calculations being made with a view of keeping the fiber stresses down to 4,000 pounds per square inch. The malleable castings for these cars of 80,000 and 85,000 pounds capacity weigh less than the gray-iron castings formerly used in 40,000-pounds capacity cars, and a saving in weight of about 43 per cent. is effected by using malleables.

FOUR-CYLINDER COMPOUNDS.

Prof. Goss, after an extended European trip last year, when he made a careful study of practice and tendencies in railroad work, in commenting on the compound locomotive, said that the four-cylinder type was the only one making progress either in England or on the Continent. It is noticeable that there is a tendency in the United States to believe that the possibilities in power and capacity of present methods are very nearly exhausted and inasmuch as four-cylinder compounds of a certain well-known type have given an excellent account of themselves here, there is reason to believe that the advantages of English and French four-cylinder compounds will be regarded with increasing interest in this country. It is believed by several well-known motive power men that the four-cylinder, balanced compound offers a greater ultimate increase in power than any other type. The reluctance



Webb's Four-Cylinder Compound for the Paris Exposition—London & Northwestern Ry.
4,000th Engine Built at the Crewe Works.
Fig. 1.

The Paris Exposition was formally opened April 14 by President Loubert with appropriate ceremonies and the affair was a brilliant success. The American section is well advanced toward completion. It will require at least a month to bring the whole up to a state of completion, and the motive power will not be ready until June. Space occupying 329,052 square feet has been allotted to this country.

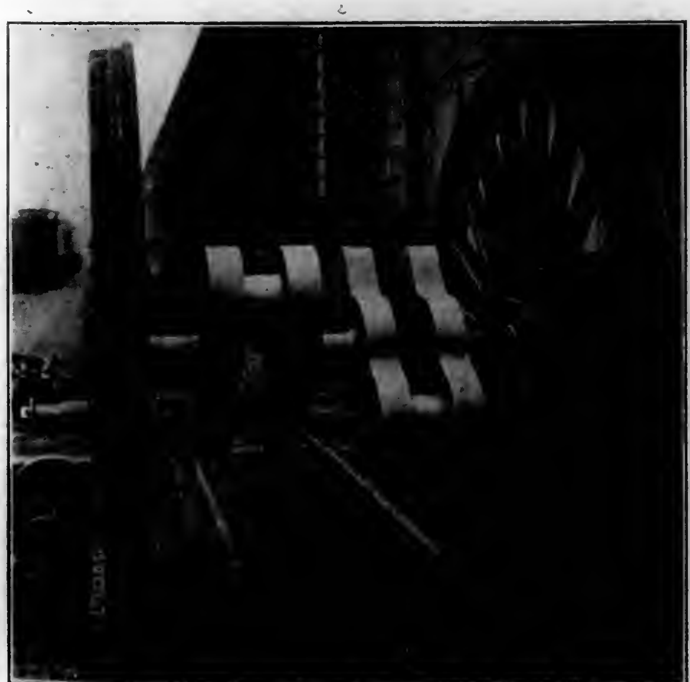
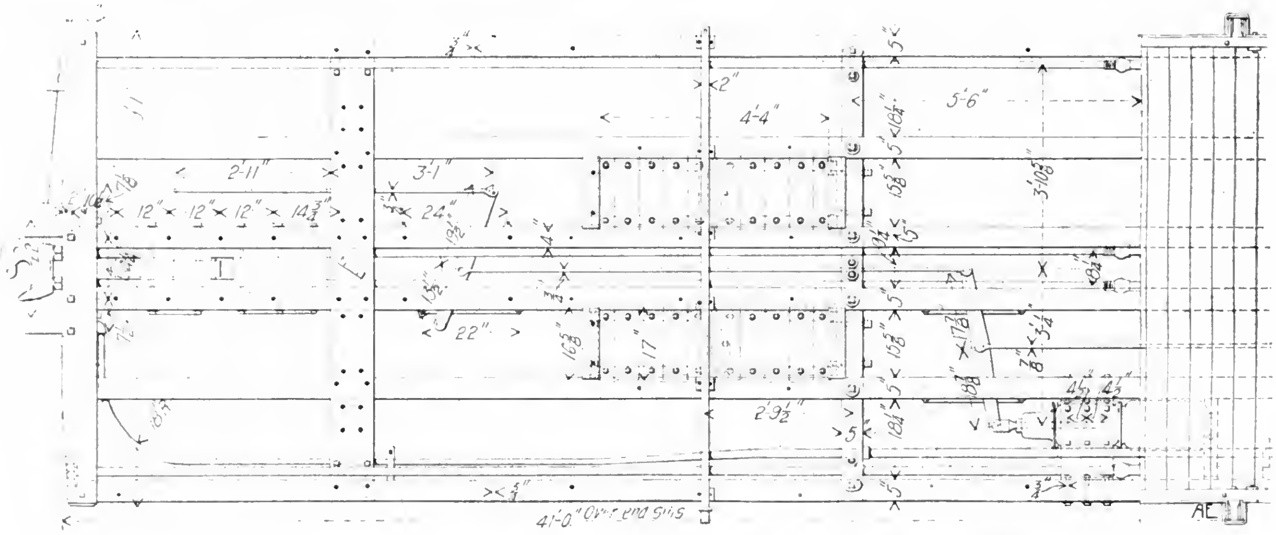
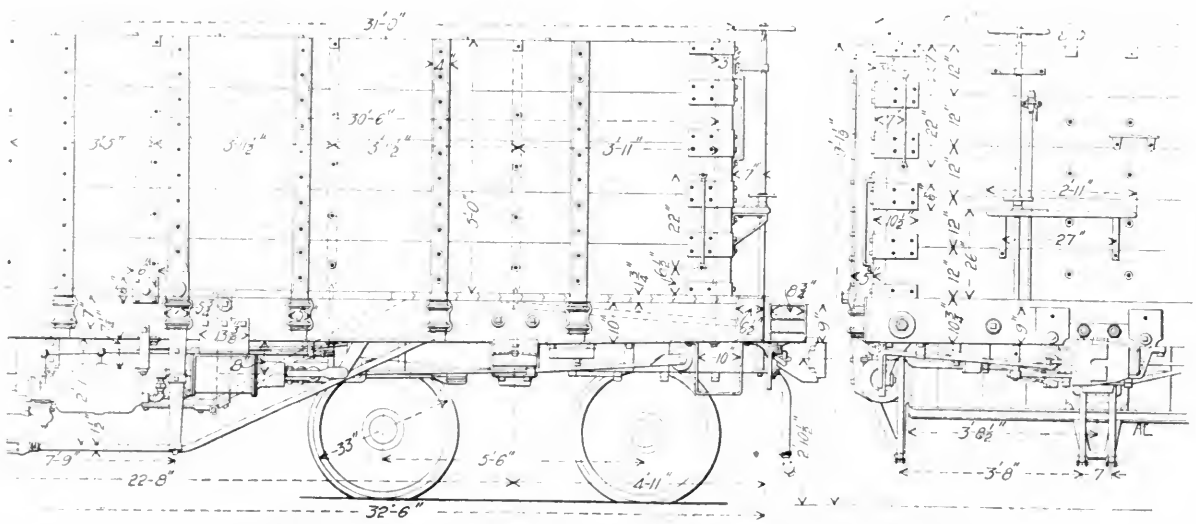


Fig. 2.—Photograph of Main Driving Wheels and Crank Axle.

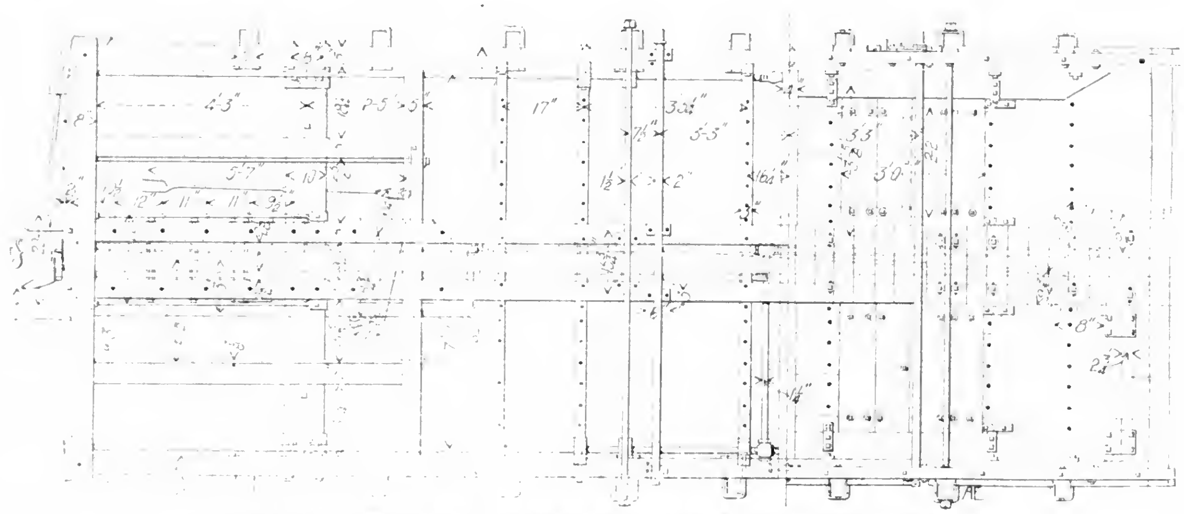
Fig. 3.—Photograph of Rear Driving Wheels and Axle.



80,000-Lb. "Shovel Car"—Buffalo, Rochester & Pittsburgh Railway.
Plan of Floor System.



85,000-Lb. "Dock Car"—Buffalo, Rochester & Pittsburgh Railway.
Half Side Elevation and Half End Elevation.



85,000-Lb. "Dock Car"—Buffalo, Rochester & Pittsburgh Railway.
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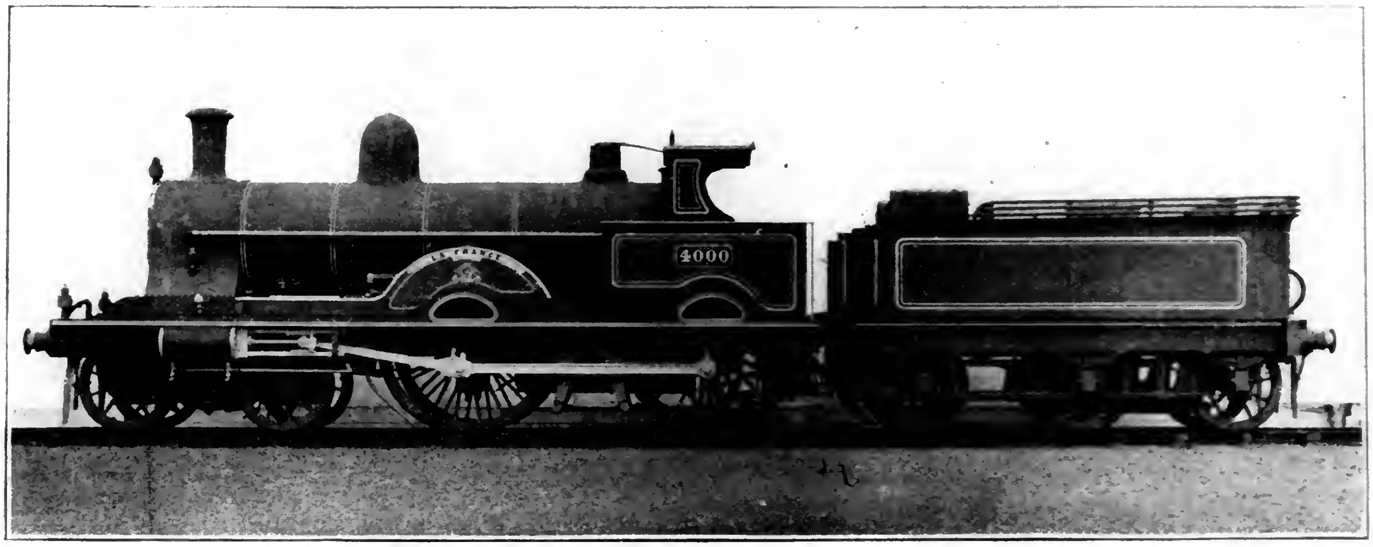


Webb's Four-Cylinder Compound for the Paris Exposition—London & Northwestern Ry. 4,000th Engine Built at the Crewe Works. Fig. 1.

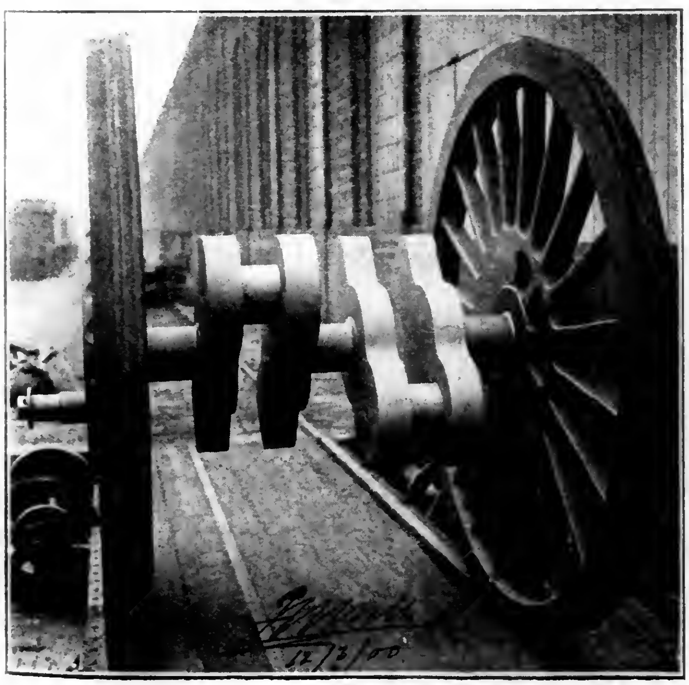


Fig. 2.—Photograph of Main Driving Wheels and Crank Axle.

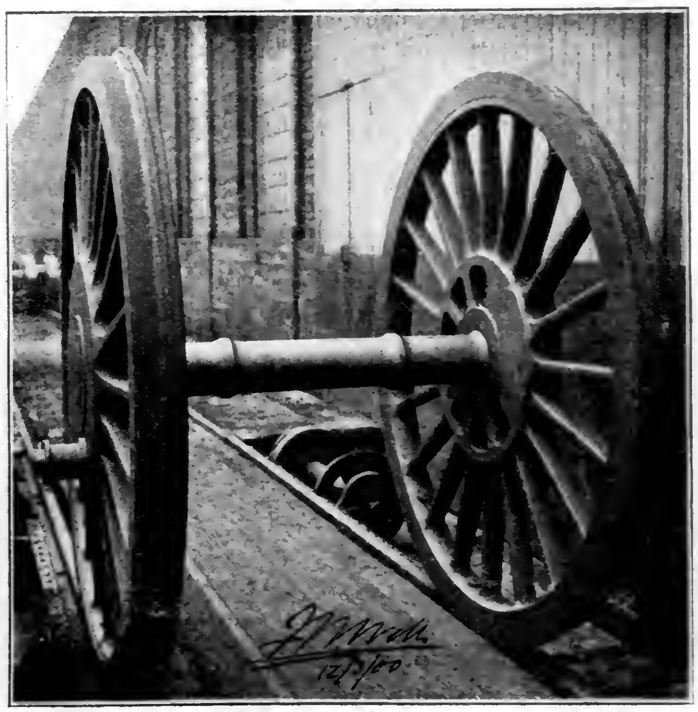


Fig. 3.—Photograph of Rear Driving Wheels and Axle.

to increase the complication and the number of working parts may defer a thorough trial of the type here for a time, but when a carefully designed engine of this kind is built and tried, this objection will probably be found less serious than it now appears. We believe in utilizing present designs to the limits of their possibilities and in keeping in mind the fact that further progress must be provided for.

Because of Mr. F. W. Webb's work in four-cylinder compounds and the success he has obtained with the principle on the London & Northwestern we asked him to permit us to illustrate the vital feature in their construction, the crank axle, and he kindly furnished the accompanying photographs and drawing. Fig. 1 is from a photograph of a new four-cylinder compound express passenger engine, "La France," which has been sent to the Paris Exposition, and is the 4,000th engine built at the Crewe Works, nearly the whole number of which Mr. Webb has seen constructed. This engine is identical with others of the four-cylinder type designed by Mr. Webb. In reading the article on page 1 of our January issue of this year the impression may have been received that the central frame originated on the Lancashire & Yorkshire. This is not the case, however. Mr. Webb's drawing, from which Fig. 4 was made, bears the date of November 30, 1886. Since that time this idea has been used in every London & Northwestern engine to which it was applicable. A great deal of trouble was taken in working it out to render the central axle box easy of adjustment with the other two boxes and without unnecessary refinement. The central frame is a deep cast-steel girder reaching from the guide yoke to a cross brace at the rear of the main axle. It furnishes a third bearing for the axle, which is in equilibrium between the springs. It is not expected to aid in carrying weight but to serve to aid in receiving the thrusts from the pistons. The wheel seats of this axle are 8½ by 6½ in., the main driving journals are 7 by 9 in., the crank axle journals are 7¾ by 5½ in. and the absence of eccentrics, due to the use of the Joy valve gear saves the space ordinarily occupied by these parts for other purposes. Fig. 4 shows the application of the central frame to six coupled freight engines with 18 in. cylinders and 60 in. wheels. The outer springs in this design are of ⅝ in. square steel with left-hand coiling, while the inner springs are coiled the other way and are made of 7/16 in. square steel. These springs are 9⅛ in. long before compressing.

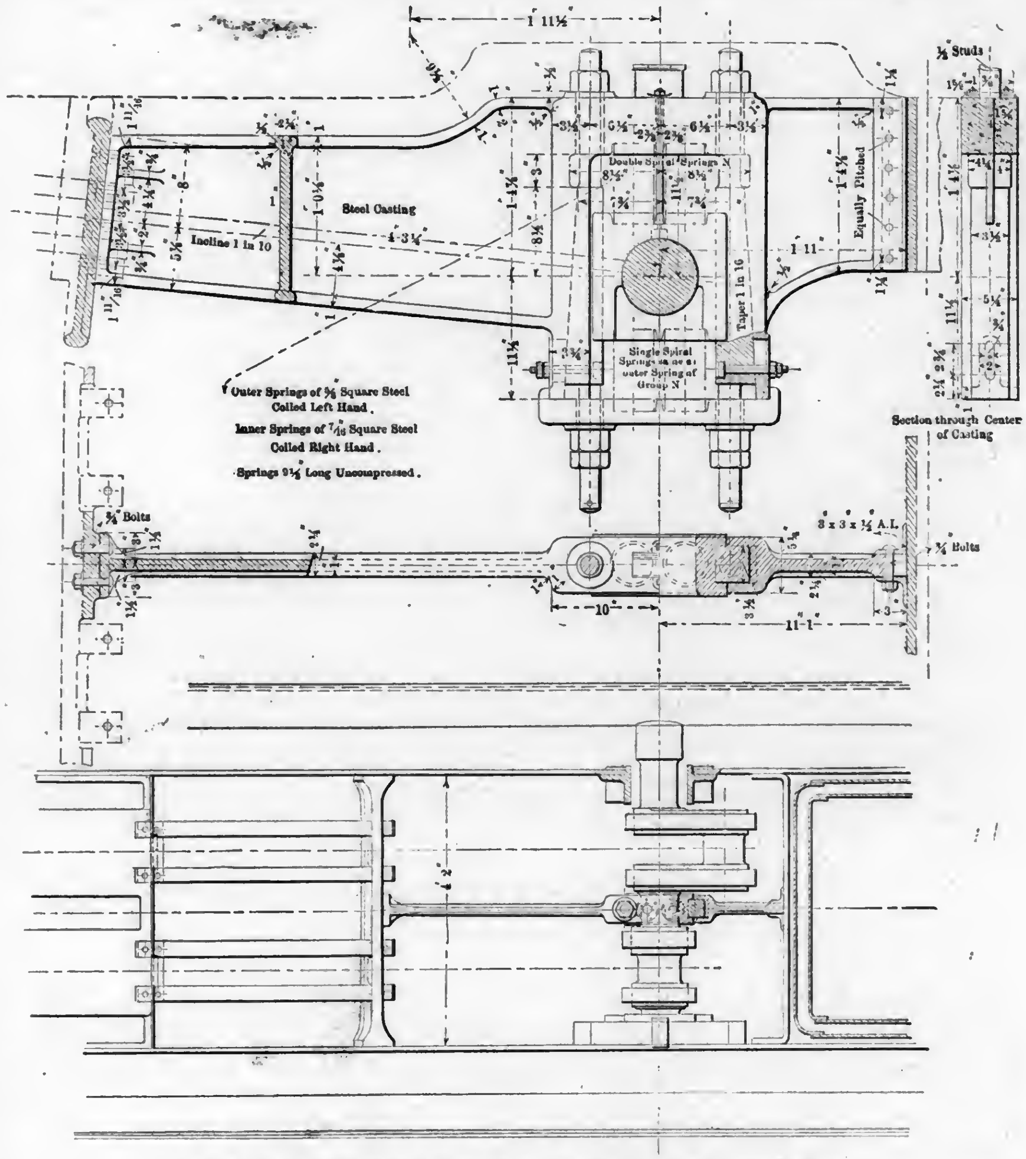


Fig. 4.—Webb's Central Frame for Four-Cylinder Compounds.

Photographs of the main and rear driving wheels and axles are shown in Figs. 2 and 3. These show the driving journals, which are large for English practice and for which this construction provides. The method of balancing both pairs of driving wheels is shown in the photographs. Mr. Webb finds no difficulty in casting these 7 ft. 1 in. wheels, and does not find it necessary to cut the rims as is generally done in this country to prevent the spokes from contracting away from the rim. It will be observed that the axle is built up. This permits of using qualities of steel for each part that are best adapted for its purpose. The crank arms are of nickel steel, while chrome steel is used for the bearings, and crank pins. With special tools for making them, these tools cost but little more than if forged solid and cut out in the usual way.

These engines have two 15 in. high-pressure cylinders outside of the frames and two 20½ in. low pressure cylinders, all having 24 in. stroke. One pair of cylinders on each side, including one high and one low pressure cylinder is operated by a single valve gear, the motion for the low pressure valves being transmitted by a rocking lever from the front end of the high pressure valve stem.

The House Naval Committee has reported an appropriation of over $61,000,000 for expenditure upon the navy this year. Last year the appropriation was $64,354,000, and these large sums indicate a new and liberal policy. In its report the committee directs attention to our naval advancements as follows: "We have a navy to-day which includes a considerable number of vessels of every class, and ship for ship it will equal that of any navy in the world. Seventeen years ago we had practically no facilities for building ships, and what we had were discredited. We were obliged to buy our armament and armor, and even in one case our plans, from foreign countries. To-day we are not only building ships in American shipyards, of American material, by American labor, on American plans, for ourselves, but also for some of the leading nations of the world. Such has been the advance which has been made in naval progress in our own country."

The Pullman Co. is introducing a patented cement flooring for cars, called "Monolith," which is controlled by them and is used on their own cars and also on passenger cars belonging to railroads. The material consists of cement, plaster and sawdust mixed with a liquid, the nature of which is kept a secret. It is spread uniformly to a thickness of about ½ in. and is reported to be hard, light and waterproof when dry; surface being smooth and easy to clean. It is being tried experimentally on the Union Pacific on a number of cars.

An interesting fact in connection with the new overland train which the Burlington is about to put into service between St. Louis and Puget Sound, by way of Billings, Mont., is that for nearly the entire distance of 2,500 miles it will run through country acquired by the United States at the time of the Louisiana purchase in 1804. When Napoleon Bonaparte, on behalf of France, sold the territory to us for about 2½ cents an acre, he little dreamed, in his endeavor to annoy England, what a magnificent empire he was practically giving away.

Iron is said to have been melted in five seconds in a recent experiment carried out by Mr. Louis Dreyfus at Thomas A. Edison's laboratory, at Orange, N. J. Mr. Dryfus represented the Goldschmidt Chemical-Thermo Industrie of Essen, Germany. He covered an iron wrench in a crucible with a chemical of secret composition and added a small quantity of powdered aluminum. The wrench, which was 6 in. long and ½ in. thick, was melted in five seconds after the chemical was set on fire, the temperature being estimated at 3,000 degrees C. The process is suggested as being applicable to the melting of rails and pipes.

The Master Car Builders' and Master Mechanics' Association's headquarters for the conventions to be held during the week of June 18 will be at the Grand Union Hotel, Saratoga. Liberal space for exhibits has been arranged for by the standing committee and allotments may be made by addressing Mr. Hugh M. Wilson, 1660 Monadnock Building, Chicago. Applicants for space should state whether they desire it upon the verandas or in the open court. The heavy machinery must be placed in the court. Steam will be piped to a central point in the exhibit space, and exhibitors requiring steam will be at liberty to connect their piping to it and will furnish their own piping and fittings. Electric current may be had from the city wires upon application to the proprietors of the Grand Union Hotel.

"Railway Bearings; A Study in Structure," was the subject of a paper read before the Franklin Institute at the April meeting, by Mr. Robert Job, Chemist, Philadelphia & Reading Railway, Reading, Pa., the author of the article upon the same subject in our issue of February, 1900, page 38. Results were given of an investigation of bearing metals to determine sources of excessive friction, and also to find out by experimentation the foundry practice by which such defects were produced, as well as the methods and manipulation necessary to ensure the most efficient results, in order to establish in the foundries of the Philadelphia & Reading Railway a thoroughly serviceable standard practice, as free as possible from observed defects. In order to gain information, a large number of bearings which had run hot and had been removed from cars of other roads while passing over the Philadelphia & Reading Railway, were examined physically, analytically and microscopically, and the defects observed were shown upon a number of lantern slides from photographs and photo-micrographs prepared in the course of the investigation. The principal defects found were: 1st, segregation of the metals; 2d, crystalline structure; and 3d, oxidation products and occluded gas in the metals. The causes by which each defect was produced were given in detail, and also the methods by which each might be avoided, giving also the standard practice which has been worked out by means of this investigation, and is in successful operation upon the Philadelphia & Reading Railway. Results of practical service tests of different metals were also shown, and a comparison between the physical tests and the practical efficiency found in service.

PREVENTION OF WEAR OF DRIVING WHEEL FLANGES.

The wearing of driving wheel flanges has always been troublesome and the fact that several roads have found it necessary to give special attention to it recently indicates that it is not entirely a question of the past. Roads differ in the extent of this trouble. Nearly all roads are very often obliged to turn off tires on account of flange wear and whenever this is necessary a lot of steel from the treads of the tires must be cut out in order to secure a full flange again. It is safe enough to say that a sure method for preventing flange wear will be welcomed by every superintendent of motive power.

The Atlantic Type fast passenger engines Class E1 of the Pennsylvania have a new feature which has a bearing upon this subject. We noted on page 23 of our January issue, in describing this engine, that the center pin of the leading truck was placed 9½ in. back of the center of the wheel base of the truck, which was done in order to relieve the front truck wheel flanges of a portion of the impact which they ordinarily receive. This increases the leverage of the forward wheels in guiding and it probably also would have a marked effect upon the leading driving wheel flanges if the engines were provided with them.

The advantages of the form of locomotive truck hanger recently adopted on the C. B. & Q. R. R. is well understood. There is nothing new about it, but the prevailing practice of using inclined links indicates that the three-point hanger is not appreciated.

On this road the question of truck hangers for mogul engines was raised by worn flanges and by several derailments, not of the trucks, but of the forward driving wheels. These occurred on rough track and led to a careful series of experiments upon the motion of the engines relative to the trucks in taking curves. The derailments appeared to be due to the peculiar action of the inclined link hangers and the insufficiency of the truck in guiding the locomotive. The swing links were 21 inches between centers at their upper ends and 23 inches at the lower ends, and about 8 inches long between centers. A rough sketch of the position of the links when the engine takes a curve, shows the disdvantages of this plan and its deficiency in guiding power. A side movement of one inch brings one of the links to a vertical position, while the angularity of the other is increased. The guidance of the engine then comes upon one link and the center casting frame is tilted.

An arrangement which will act as a parallel motion and serve as a powerful guide to the front end is required. This is best secured by three point hangers, the principle of which was favorably reported upon by the Master Mechanics' Association in 1896.

The heart-shaped hanger shown in the accompanying engraving, Fig. 1, resulted from the investigation on the Burlington. Its form is clearly indicated, and special attention is directed to the distance between the centers of the upper pins. This was made 3 inches at first and was increased in order to increase the power of the truck to guide the engine and relieve the driving-wheel flanges. This distance on the consolidation engines of the Pennsylvania, Class H5 and H6 is 3½ in., as shown on page 184 of our issue of June, 1899.

Now that 6 by 12-inch truck journals are coming into use it will not always be easy to find room for such hangers, but their unquestioned value warrants efforts to use them and for four wheel as well as two-wheel trucks.

The sharpening of flanges on the leading driving wheels of a locomotive indicates that the truck does too little guiding, and the sharpening of the flanges of the truck wheels indicates that they do too much guiding. Opinions differ as to how to adjust this effect and the discussion of the relative values of different methods of arranging hangers, as presented on page 321 of the Proceedings of the Master Mechanics' Association for 1896 is appropriate here. Figs. 3 to 10 are reproduced from that record as showing the methods of arranging swinging links which are in common use. In Fig.

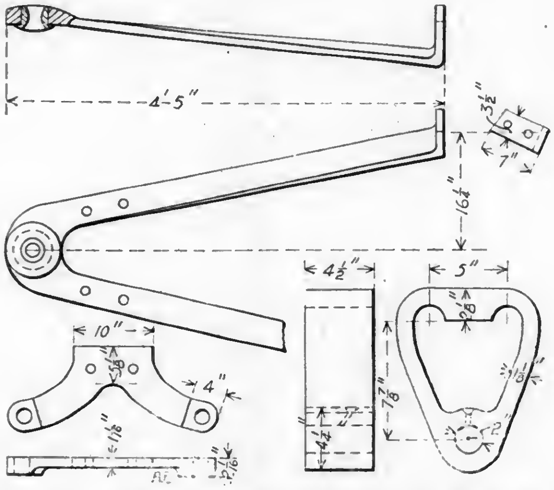
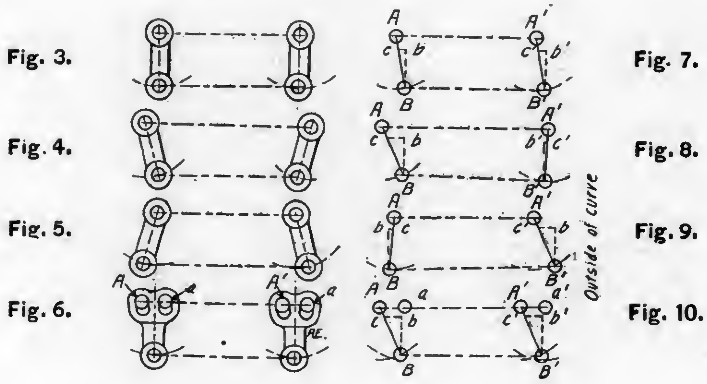


Fig. 1.—Three Point Truck Hangers.—C., B. & Q. R. R.



3 the links are perpendicular, in Fig. 4 the upper ends are further apart than the lower ends, while the reverse arrangement is shown in Fig. 5. The three point hanger is shown in Fig. 6, this being similar in principle to the C., B. & Q. hangers of Fig. 1. The action of the various hangers appears in Figs. 7 to 10, in which the center lines of the links only are represented and the outside of the curve is supposed to be at the right side of the engraving. When an engine with swinging links strikes a curve the bolster B B[1] tends to move toward the outside rail, and this swings the lower ends of the links toward the right. Without going into the details these diagrams

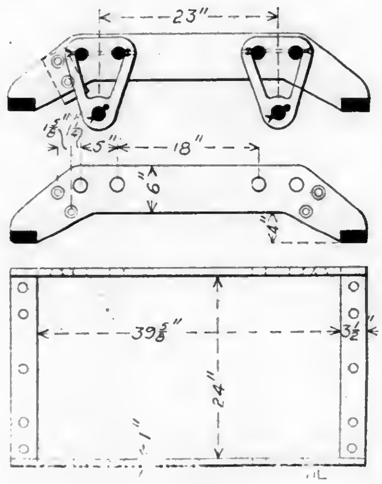
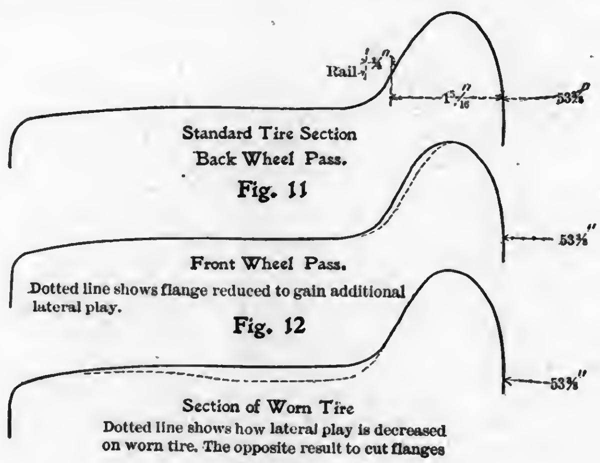


Fig. 2.—Truck Hangers.—C., B. & Q. R. R.

clearly indicate the importance of keeping the links parallel. The three point hanger does this and its advantage in the tendency to return to its normal position is shown by the length of the line cb and c[1]b[1] in Fig. 10 as compared with the corresponding lines of the other diagrams. If from the centers B B[1] in Fig. 7 perpendicular Bb and B[1]b[1] are erected, whose length will equal the weight resting on the lower ends of the hangers, the horizontal lines c b and c[1] b[1] drawn from their upper end to the center lines of the hangers will represent the lateral pressure exerted by the weight resting on the hangers. In Figs. 8 and 9 the lateral forces exerted by the links actually oppose each other. This is a strong argument in favor of the three point hanger.

On the Lake Shore & Michigan Southern, which has a comparatively straight track with maximum curves of 6 deg. on the main line, a very simple method was applied to the new consolidation engines built by the Brooks Locomotive Works (see February, 1900, page 37), from a suggestion by Mr. John Player, Mechanical Engineer of the works. The pony truck is expected to do its share of the guiding, and the driving wheels,



Standard Tire Section
Back Wheel Pass.
Fig. 11

Front Wheel Pass.
Dotted line shows flange reduced to gain additional lateral play.
Fig. 12

Section of Worn Tire
Dotted line shows how lateral play is decreased on worn tire. The opposite result to cut flanges
Fig. 13

Line Sections—D., L. & W. R. R.

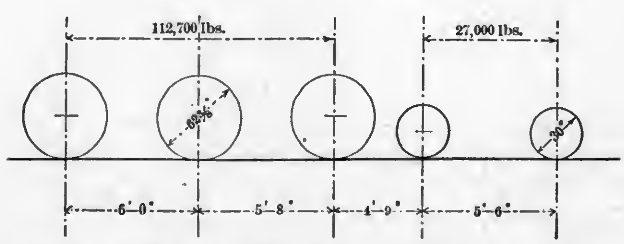
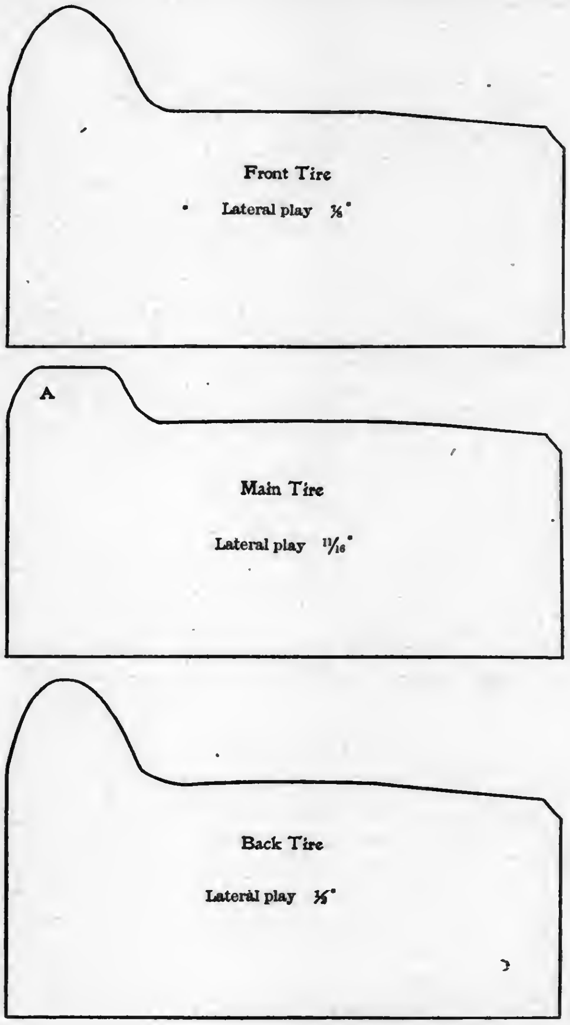
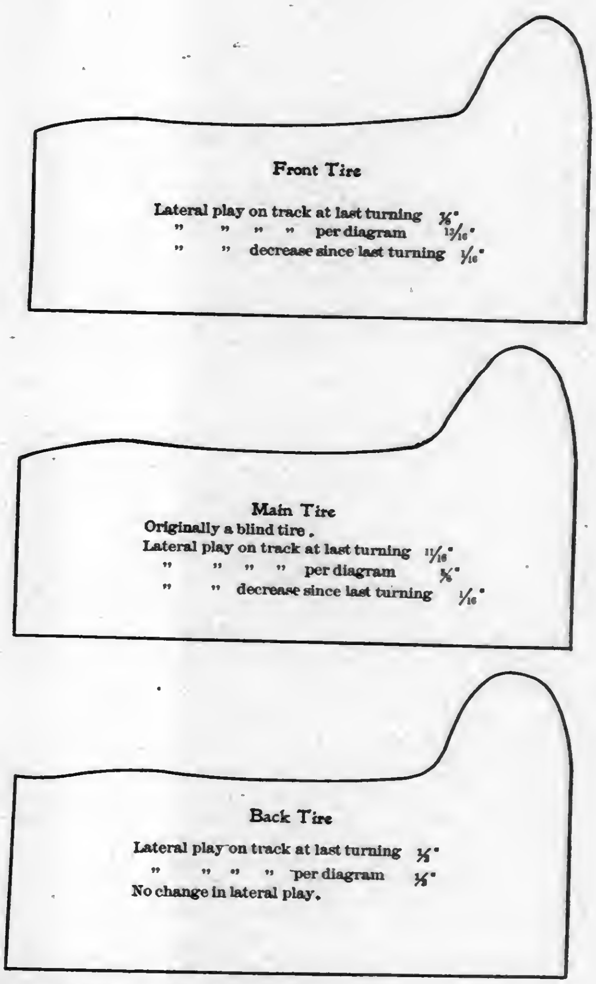


Fig. 16.—Wheel Arrangement of Locomotive of Fig. 3, 14, and 15

which are all flanged, are made to help. The tires of the first and last pairs of drivers are closed in toward each other to a distance of 53¼ in. between the backs of the flanges, this being ⅛ in. less than the standard distance between the tires. The second and third pairs of tires are set out to 53½ in. between





TIRE SECTIONS FROM 10-WHEEL LOCOMOTIVE—D. L. & W. R. R.

Fig. 14.

When this engine was received from the builders the main tire was "blind." After two tire turnings the flange "A" was formed.

Fig. 15.

After 16 months, 8 days' service, during which the engine ran 71,930 miles, these sections of the tires were taken.

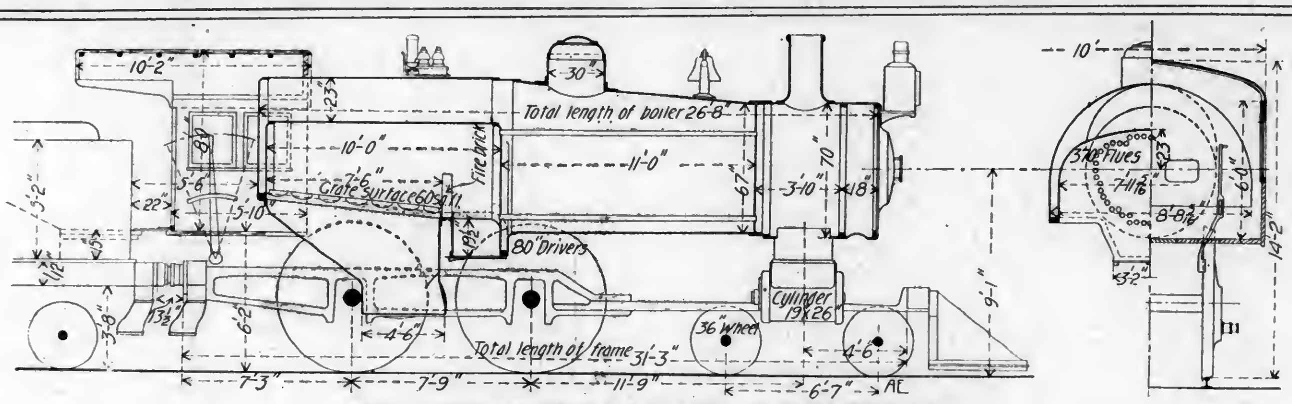
the backs of the flanges, which is ⅛ in. more than the standard distance. With this arrangement the second and third pairs of flanges will do some of the guiding. The effect appears to be to give the same result as far as the wheels are concerned as is obtained by the wear of the flanges in service. Mr. Marshall expects good results from this arrangement.

Those who have not been aware of the practice of the Delaware, Lackawanna & Western R. R. will be interested to know that for 30 years this road has had no trouble with worn flanges and has used flanged tires on all wheels during this time. Readers may at first be incredulous when we say that on this road the driving wheel flanges grow thicker at the throat as the tires wear, but those who take the trouble to inspect the tires in use and on the scrap piles of this road will be convinced, as was our representative, that this is true. While the plan has been repeatedly mentioned before the Master Mechanics' Association, it, as far as we know, has never been described. We do not say that equally good, if not exactly the same results can not be obtained in other ways, but that the method used on this road is successful in stopping flange wear appears to be certain.

Mr. W. C. Conwell, who has been foreman of the Scranton machine shops of this road for 45 years, made a study of this subject long ago in connection with the reduction of the gage of tracks from six feet to the present standard. When this was done much trouble was experienced because of very rapid wear of flanges and Mr. Conwell made a very thorough analysis of the causes. He soon saw that the plain tire did not contribute to the guiding of the engine and that in consequence it threw heavy responsibilities upon the flanges of the other wheels. He then made up his mind that the problem could be solved by putting the tires, when new, into the condition as to lateral play into which they were brought by wearing. By "lateral play" we do not mean the longitudinal play of the driving journals in the boxes, but the play of the wheels with reference to the gauge of the track. The total lateral play at the driving boxes on this road is 3/16 in. which is 1/16 in. less than is usually provided.

Through the courtesy of Mr. J. W. Fitz Gibbon, until recently Superintendent of Motive Power of the Lackawanna, we are permitted to describe this interesting practice, which consists of making the distance between the inside faces of all tires a standard of 53⅜ in., the lateral play of the wheels upon the rails being different for the various axles, this play being provided for by the thickness of the flanges. The distance between tires was made to suit the guard rails, and the questions concerning the inside and outside of the tires were considered separately.

The simplicity of the plan appears in the diagrams. Fig. 11 shows the original tire section for the rear wheel of a 4-wheel connected passenger engine in which the lateral play is ¼ in. on each side, or a total of ½ in. The dotted line in Fig. 12 shows the form of the flange of the front wheel to secure the amount of lateral play required. This principle applies to all



A Locomotive Study.—A Suggestion in Wide Fireboxes.

classes of engines and for those wheels which are given a lateral play of ½ in. the tire section differs very little from the Master Mechanics' Association standard. The other flanges are pared down on the lathe to make them thinner. The usual method of wearing is indicated in Fig. 13. On a number of engines which have been in service from 15 to 20 months the flanges were found to be thickened at the base, Fig. 13, which reduced the amount of lateral play and was exactly the opposite to cut flanges. In some of the cases of old tires, examined by the writer, the flanges were reduced very slightly in thickness below the original size, but there was not a single case of "cut flange." In the large majority of cases the flanges remain at the original thickness or are increased at the base as shown in Fig. 13. Engines with this tire treatment have made 150,000 miles between tire turnings.

As shown in the table, the wheels of 4-wheel trucks are made with the smallest amount of play, ¼ in. on each wheel, with a view of making the truck do a lot of guiding. In the case of pony trucks 3/16 in. play is given on each side. The purpose of the difference in play among the driving wheels is by allowing considerable play to make the leading drivers do some of the guiding and by giving less play to the second, third and fourth pairs to make each pair do its share. The rear wheels of the four and six coupled engines are made with the least amount of play in order to "center" the rear end of the engine on the track, and in the 8-coupled engines the front and rear wheels are given the same amount of play in order, as Mr. Fitz Gibbon puts it, to "make the engines fit the curves."

The rule for the allowance of the flange play is as follows:

Mogul type....Front wheels, ⅞ in; main wheels, ⅝ in.; back wheels, ½ in.
Eight-wheel type .. front wheels, ⅞ in....back wheels, ...⅛ in.
Consolidation..Front and back wheels, ⅞ in.; second and third, ⅝ in.
Engine truck wheels (4-wheel truck)..............................½ in.
Engine truck wheels (pony truck) ....⅜ in.
Total lateral play at driving box hubs ....3/16 in.

It has been argued that the same result may be obtained by giving the play or side motion in the axles by making these allowances in the play between the driving wheels and the driving boxes, instead of having it between the flanges and the rail. Whether this is true or not, it is evident that the effect of the D., L. & W. method makes the wheels fit the rails easily on curves, and it is apparently entirely satisfactory. The locomotive trucks on the main line of this road are all of the swing motion type. Mr. David Brown, Master Mechanic at Scranton, informs us that the flanges of the driving boxes are tapered on the inside from the top and bottom to permit the boxes to tip with the axles as they take the elevation of the outer rail on curves. The central portions for a length of 3 inches are parallel, while the top and bottom of the opening is ⅛ in. wider than the central portion.

Some of the engines on this road make 11,000 miles per month in regular service which indicates that they are not petted. The plan is now on record and we shall be glad if the description calls out the comment of readers.

Mr. G. W. West, Superintendent of Motive Power of the New York, Ontario & Western, has used for some years an adaptation of the D. L. & W. plan. He places the tires of the forward and rear wheels a little closer together than the middle ones of ten-wheel and consolidation engines. The middle wheels are kept at the normal distance.

A LOCOMOTIVE STUDY.

By Edward Grafstrom.

Mechanical Engineer Illinois Central Railroad.

While it does not represent a new type of locomotive, the accompanying engraving may be of interest as showing a novel adaptation of the wide firebox to a fast passenger engine of the American type. This has not been attempted heretofore, at least not in this country, except to the extent of the Belpaire firebox, reaching over the frames, though not over the drivers.

The Atlantic type of engine came into existence to meet the conditions essential to the modern high-duty express engine, which are summed up in the expression, sustained speed. Not the burst of speed which a little 18 by 24-inch engine occasionally makes over a level stretch, nor the rushing along of an "extra" with three or four cars, on a special schedule; but the speed that tells, the steady pull day after day, regardless of weather conditions or of extra cars, at a scheduled 50-mile gait, that can be forced 50 per cent. when there is lost time to make up. For such work steam is needed, and lots of it, but every pound of water evaporated requires a certain quantity of coal, and every pound of coal burnt needs a certain amount of grate area, and thus the problem has resolved itself into two controlling elements: grate area, and muscle wherewith to supply the same with coal.

It is not the purpose here to expostulate on the merits of the Wootten firebox or its modifications. Suffice it to say that it has been resorted to when the Belpaire or radial stay type reached the limit of length at which a fireman's coal shoveling ability ceases. The Atlantic type of engine is, as already stated, the outcome of this demand for grate area in combination with large drivers, and from an engineering point of view, purely, it answers the purpose well enough. The principal objection to it is that the engineman has to be entirely separated from his fireman. Several instances are on record pointing to the great risk of entrusting the lives of a number of passengers to the care of one mortal man, and he beyond the reach and observation of others perhaps for half an hour or more at a time.

In October, 1898, an Atlantic type engine on an Erie night express ran ten miles with a corpse at the throttle, before the fireman became aware of the situation. Three years ago a similar instance happened on the Philadelphia & Reading, and it is still in fresh memory of many New Yorkers how a pilot was found dead at the wheel of a ferry boat, since which it has been compulsory to carry a second man, usually a deck hand, in the pilot house of the ferry boats. If the writer is correctly informed, legislation has also been evoked in some western States, practically making engines with cabs in front of the firebox prohibitory, unless an extra man rides in the cab with the engineman. Admitting that such cases are rare, there still remains an element of security in knowing that two men can compare notes when indistinct signals and train orders are of doubtful meaning.

The idea embodied in the design shown in this connection

is of foreign origin, but is equally applicable to the 10-wheel and the American type of engines in use in this country. Without describing the design in detail, attention is called to the combustion chamber between the flue sheet and the bridge wall, which may be cleaned out through the drop door at the bottom. This door, it is thought, will also permit of the caulking of flues and similar work without tearing down the brick arch or waiting for it to cool. The rear end of the cab has been left open, as the heat radiating from such wide fireboxes is, as a rule, considerable, regardless of how completely the boiler inside the cab is lagged. The raised floor in the coal space of the tender has already been found necessary on several recent 10-wheel engines, and is not objectionable.

In conclusion it should be said that the design is merely a study in a somewhat new line, open for criticism and possibly further developments, and it is offered as a suggestion and not as a finished product.

STATIONARY SHOP BOILERS.

A contrast of stationary boiler practice, showing the advance of twenty years, is to be seen in two adjacent boiler rooms of a certain railroad shop. One, just completed, is equipped with modern water-tube boilers, with automatic stokers, and machinery for handling coal and ashes, and the other, which is soon to go, has a lot of old locomotive boilers. The first represents the thought and care of the mechanical engineer, and the other is a type of practice for which no favorable argument can be advanced. This plan, however, does not require requisition or correspondence, and this probably explains its existence. There is an awakening to the possibilities for improvement which is shown by the recent installation of a number of thoroughly up-to-date boiler plants in railroad shops, and by the appointment of a committee to consider the "Best Type of Stationary Boiler for Shop Purposes," for report at the approaching convention of the Master Mechanics' Association.

We do not wish to be understood to advocate the investment necessary for coal and ash-handling machinery, mechanical draft, or automatic stokers, in all cases. These are advantageous only under certain conditions, and these are determined chiefly by the size of the plant. But what we do advocate is a thorough treatment of the subject of steam production in the plans for new shops and the rebuilding and extension of old ones.

In the circular of inquiry issued by this committee the first question is as follows: "From your experience, do you prefer locomotive type boilers with internal fireboxes, return tubular boilers bricked in, or water-tube boilers?" The selection of the type of boiler is most important, and the three most recent examples of improved shop practice testify to the advantages of the water-tube type. In the matter of repairs, especially, it is to be hoped that the replies from members will show the relative costs of various types. In this connection it is interesting to know that water-tube boilers have been in constant use in large batteries for more than ten years without costing anything for repairs.

Water-tube boilers are usually capable of being forced far beyond their rated capacity, but with this exception it is possible to select a water-tube boiler which is really inferior to a return-tube boiler of the common form. The rapidity of steaming and of getting up steam pressure, together with the possibilities of greatly increasing pressure while keeping within the limitations of weight, have brought the water-tube boiler into the naval practice of several governments. The rapidity of getting up steam pressure has been strikingly expressed by some one, who has said that if English naval vessels had tank boilers and French vessels had the water-tube type, and fleets of both nations lay at anchor on their respective shores of the English channel, with the boilers all cold, the French fleet could reach the shores of England before the English ships could move from their anchorages.

The matter of weight is not important in stationary work, but the rapidity of steaming, and the ready response to sudden fluctuations in the demand for steam, have brought this boiler into electrical distribution practice, until we now see this type selected for the enormous aggregations in the power plants now under construction for the most extensive electric railroad systems in the world. The concentration of steam and electric power generating plants into one power house is now the rule in the construction of large shops, and this involves the use of power all over the plant for work that was formerly done by independent steam plants or by hand. This will naturally be accompanied by considerable fluctuations of load, which will require corresponding flexibility in the production of steam, so that the water-tube boiler meets the same requirement in the shop as in the electric railway power house.

The evaporation of water per pound of coal, of course, depends upon the coal, but in a well-designed water-tube boiler the ratio may be expected to be from 5 to 10 per cent. greater than in the return-tube boiler, with the same quality of coal in each. With Pocahontas coal, over 11 pounds of water per pound of dry coal, from and at 212 degrees, have been evaporated in a water-tube boiler. In forcing, these boilers have given satisfactory economy when burning as much as 35 pounds of coal per square foot of grate per hour.

It is not enough to speak of water-tube boilers as a type because of the great differences in the representatives of the type and in the selection. Burtin, in his "Marine Boilers" (page 233), divides them into three distinct groups, (a) those with limited circulation, (b) those with free circulation, and (c) those with accelerated circulation, the question of circulation being considered by him as one of fundamental importance. It is a vital factor in a steam boiler that the water should circulate, and this is one of the ways in which the cylindrical and locomotive types are defective. It has not been given its place in boiler design, and the water-tube boiler has been an educator in this direction.

Other considerations in the selection of boilers may be mentioned as follows: (1) The division of the water space into relatively small sections, with a view of confining a possible rupture to a small portion through which the pressure may find relief without danger of explosion. (2) Accessibility of all parts for cleaning and repairs. (3) Removal of the joints from the direct influence of the fire and provision for collecting mud in a drum that is removed from the fire. Of these probably the most important are those concerning the division of the water space and the accessibility for repairs. There appears to be an advantage in straight over curved tubes, and of course stayed surfaces should be avoided. Straight tubes are easier to clean than curved ones, as well as being easier to replace, and it is clear that a few tubes may be carried in stock for replacement in boilers in which all the tubes are straight and of the same length, whereas a much larger number must be available if they are of different lengths and curved differently. Furthermore, it is important to be able to get at tubes from both ends for cleaning.

Superheating is, perhaps, too great a refinement to expect for the present in shop practice, but when it has been reached another strong point of the water-tube boiler will be seen.

"The radical defect of prohibition is that it does not prohibit, of protection that it does not protect, of the radial stay that it is not radial, and of the cinder retaining extended smokebox that it does not retain the cinders." This was said by Mr. J. Snowden Bell in discussing the subject of locomotive front ends before the Western Railway Club. It is not so much a pessimistic expression as a warning to the effect that a name is not alone sufficient to make a device successful, and that we should not be satisfied when a thing is named.

Gas made in "Mond" producers capable of evaporating seven tons of water per ton of coal used was referred to by R. E. Crompton before the Institution of Electional Engineers (England) recently. This gas is equally applicable for use under boilers and in gas engines.

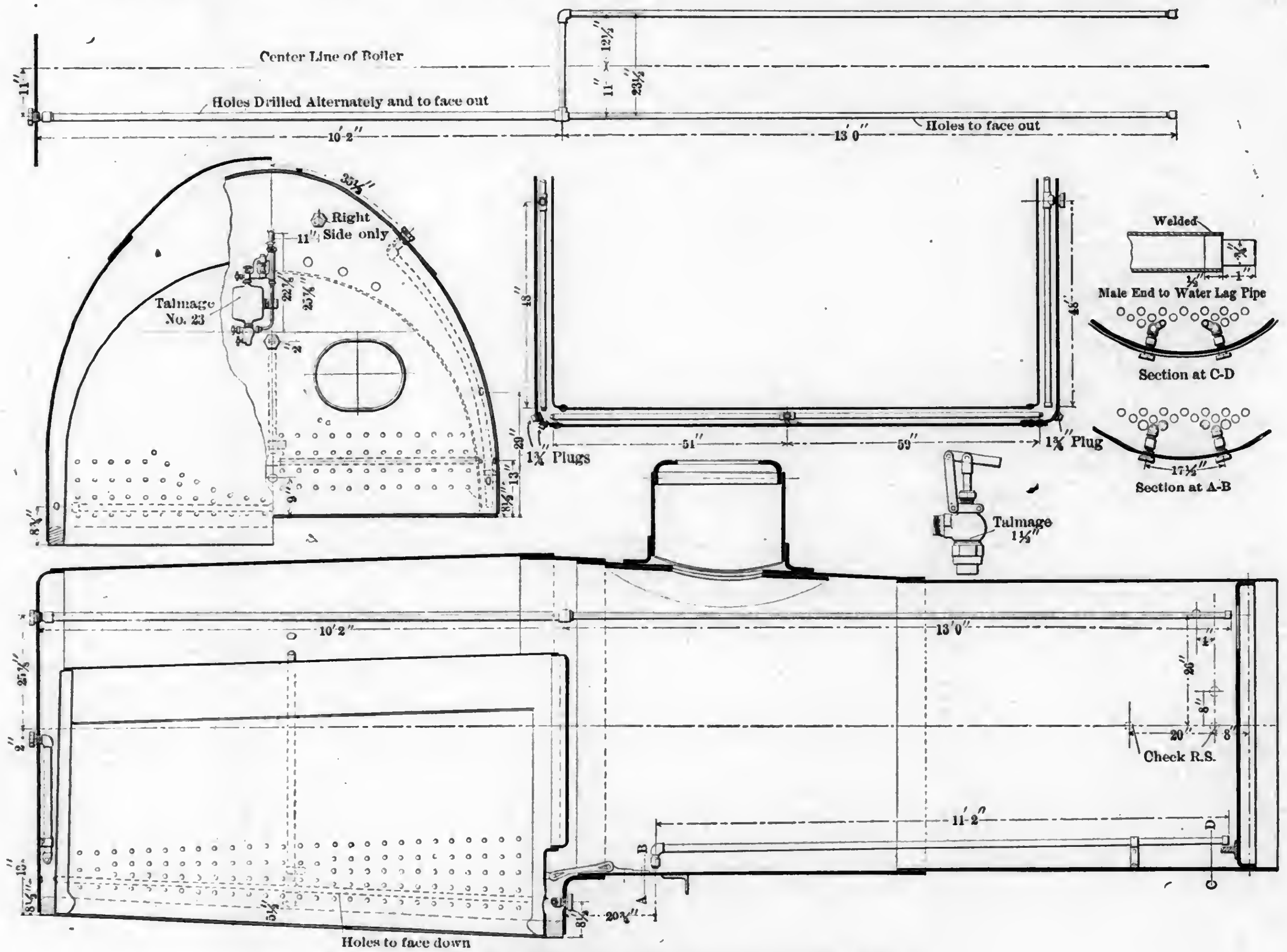
A SIMPLE AND SUCCESSFUL SCALE PREVENTION METHOD.

Erie Railroad.

Locomotive men have sought for years to find a satisfactory way to avoid the serious difficulties connected with the use of bad waters. Mr. A. E. Mitchell, Superintendent of Motive Power of the Erie Railroad, has tried a great many so-called remedies, including a long list of "patent medicines," and as a result of continued unsatisfactory experience he was naturally skeptical when a new plan was suggested. His characteristic thoroughness as an investigator, and confidence that oil could be used, led him to the study and development of the possibilities of the Talmage system, which we describe, and which is pronounced to be an unqualified success when properly operated.

Mr. J. G. Talmage, President of the Talmage Manufacturing Company of Cleveland, who had a long experience in the use of mineral oils in stationary boilers, was consulted by Mr. Mitchell in 1896 with reference to the application of oils in locomotive boilers. This led to some experiments which were not successful, but they indicated the desirability of using specially high test oils. This led to the preparation of what is known as "Rubra" oil, which is now regularly manufactured for this special purpose by the Talmage Manufacturing Co. It is a specially distilled hydro-carbon oil, entirely free from tarry and resinous matter. Its high fire test renders it safe in high-pressure boilers, and it does not decompose or form deleterious carbonaceous residues. The previous difficulty appeared to result from the distillation of the low fire test oil over with the steam, and raising the fire test to a point above the highest temperature of the water and steam immediately overcame the trouble. The system consists in feeding this oil into the boiler by means of a specially designed automatic feeder from which the oil is fed under control of the engineer. This feeder is generally placed on the left-hand side of the boiler head, within easy reach of the fireman. The system is completed by a number of blow-off valves used in connection with a system of perforated pipes. The arrangement of the system as applied to a standard wide firebox engine on the Erie is shown in the accompanying engraving.

The action of the oil is purely mechanical. It does not prevent the formation or precipitation of the incrusting solids, but when these are formed they seem to be at once enveloped in a film of the oil, which prevents them from sticking to the heating surfaces and throws them down in the form of mud, which may be blown out. The action of the oil is to surround the particles of the precipitated matter and prevent their crystals from cementing together or sticking to the heating surfaces. Before the application of the system the heating surfaces are coated with the oil. In this way the heating surfaces, including the crown sheets and tubes, are kept almost perfectly clean when the system is applied to a new engine. The oil prevents the corrosion and the pitting action of certain waters. The high fire test prevents the oil from vaporizing and distilling over with the steam, but the effect of the oil in the water is very marked upon the gauge cocks and blow-off cocks and the packings of the throttle stem, valve stems and piston rod, and also upon the wear of the cylinders and piston packing. These seem to



The Talmage System of Caring for Locomotive Boilers. Applied to Standard Wide Firebox Engine, Erie R. R.

be lubricated, and they are kept free from the precipitate. This is the testimony of the boiler makers and the engineers. Most careful examinations including chemical analyses of the scale from all parts of the boiler, show that the oil has no harmful effect whatever on the plates, and there is no corrosion of tubes or sheets. The heating surfaces in many of the waters appear to be black, and upon analysis it was found that this was due to iron from the water. Experiments to show the tendency to cause foaming developed the fact that even with the excessive feed of three gallons of oil in thirty minutes there was no foaming. Mr. Mitchell, fearing that some source of danger might be overlooked, even went to the extent of an examination of the oil with reference to the possibility of explosion in case a lighted lamp should be carried into the boiler. This is guarded against by the high fire test. The oil is therefore spoken of as perfectly harmless.

The Talmage system has become a part of the regular practice of the Erie Railroad, and is being introduced on other roads. It has just been applied to fifty new engines on the Erie, which are of the consolidation type with Wootten fireboxes. Its effect upon the operation of the mechanical department is to place the bad water districts upon very nearly the same basis with regard to boiler washing as those having the best water. It costs about $2.25 to wash out a boiler. This, however, does not compare in importance with the fact that each engine must be held from six to eight hours every time the boiler is washed. The saving of one boiler washing permits an engine to make a trip over a division of 100 miles, and with 47 engines on one of the divisions this advantage amounts to the continuous use of five engines. On one division the boilers required washing out every 500 miles before the oil was applied, and they are now kept in much better condition than before by washing out once in 3,000 miles, and, in some cases, 5,000 miles. In October of last year the system was in use on 49 locomotives, of which 25 were on the Cincinnati Division and 24 on the Lima Division, The cost of application of the system to each engine was not more than $125 in any case, but the cost depends, of course, upon the construction of the boilers. Upon the application of the oil the mileage began at once to increase, the boiler work to decrease and the life of flues to increase. On the Lima Division the engines make an increased mileage averaging 504 miles per engine per month, due to the fact that the boilers are washed out but once in thirty days. The largest mileage between washings in these bad water districts, so far recorded, is 6,000 miles. On the Cincinnati Division the increased mileage between washings has been over ten fold, giving an advantage of 432 miles per engine per month. This resulted in the additional saving in the boiler washing force of two men at Galion and two men at Huntington, the saving at these two points amounting to $192 per month in wages. The average increased life of flues upon engines, of which close record has been kept, has been between 30 and 40 per cent., depending largely upon the service. Engine No. 770 has run for 18 months with one set of flues. The life of flues was formerly 8 months. In the 18 months mileage has been 77,498, and the flues were then taken out for safe ending. The former mileage of flues was between 41,000 and 48,000. Engine No. 780, after making 61,527 miles, required the renewal of only 100 flues, and at the time of the report the rest of the flues had made 78,788 miles and were still in good condition. The increased mileage per engine per month on the Lima Division averaged 504 miles, and on the Cincinnati Division 432 miles. On these divisions the average mileage between washings is 3,500.

The deterioration of the special apparatus of this system is practically negligible. While the average cost per hundred miles on these divisions has been about 30 cents, the increase in the life of flues has been 30 per cent. and of fireboxes 20 per cent., with the engine mileage increased as stated.

In January, 1900, Mr. Mitchell called a meeting of the shopmen, enginemen and motive power officers concerned, and discussed the system thoroughly. The result was its adoption. After an experience of several years, during which the system was in the care of the Talmage Manufacturing Company, circulars of instruction were issued, and the entire operation taken into the hands of the railroad. Because of the importance of the subject and of its development under the personal care of Mr. Mitchell, the circular drawn up by Mr. Talmage, with the assistance of Mr. Mitchell, is reproduced, and it will be seen that a great deal of care is required in the use of the blow-off cocks and in the feeding of the oil. We are indebted to Mr. Mitchell and Mr. Talmage for the information and drawings. The results obtained are in no way sensational, although they are exceedingly important. They testify of the value of following such a subject carefully for a number of years, and the experience of this road is now made available for others. The instructions follow:

To properly carry out the principle of this system, the enginemen should feed the oil regularly and continuously into the boiler when the engine is in service. Specific directions will be furnished to meet the various conditions, as the quantity of oil to be used varies according to the condition of the water and the amount evaporated.

The surface blow-off draws from the entire surface of the water, and will carry off all impurities from that portion of the boiler. It is designed to be used on the road as well as at terminals. Certain waters contain ingredients which, if allowed to accumulate in the boiler, will cause the water to foam. This action is effectually overcome by the use of the surface blow-off. In operating the surface blow-off, the enginemen should be governed by the amount and condition of the water in the boiler, care being taken to avoid the excessive loss of water during this operation.

When the hostlers and engine preparers place the engine on the dump track for blowing, the boiler should have three gauges of water and full pressure of steam. The surface blow-off should be operated first, to reduce the water in the boiler to 2½ gauges. Then each of the other blow-off valves should be operated a uniform length of time, care being taken not to reduce the water in the boiler below one gauge.

Injectors should not be used while blowing off. The blower should not be used until the blowing off of boiler has been completed, and then used to bring steam up to pressure required.

When the boiler washers blow the steam off there should be at least one gauge of water in the boiler, to avoid the heat from drying the flues and sheets.

The crown sheet should be washed immediately after the water has been drawn off from that portion of the boiler, and while the water is being drawn from the lower portion of the boiler.

When the washing is done with cold water the boiler should be properly cooled before drawing the water off.

This system is the result of a patient and painstaking development of principles which have been applied before but always unsuccessfully. They represent a number of years of concentrated effort and study of the conditions of locomotive boiler operation. We understand that this system is protected thoroughly by patents.

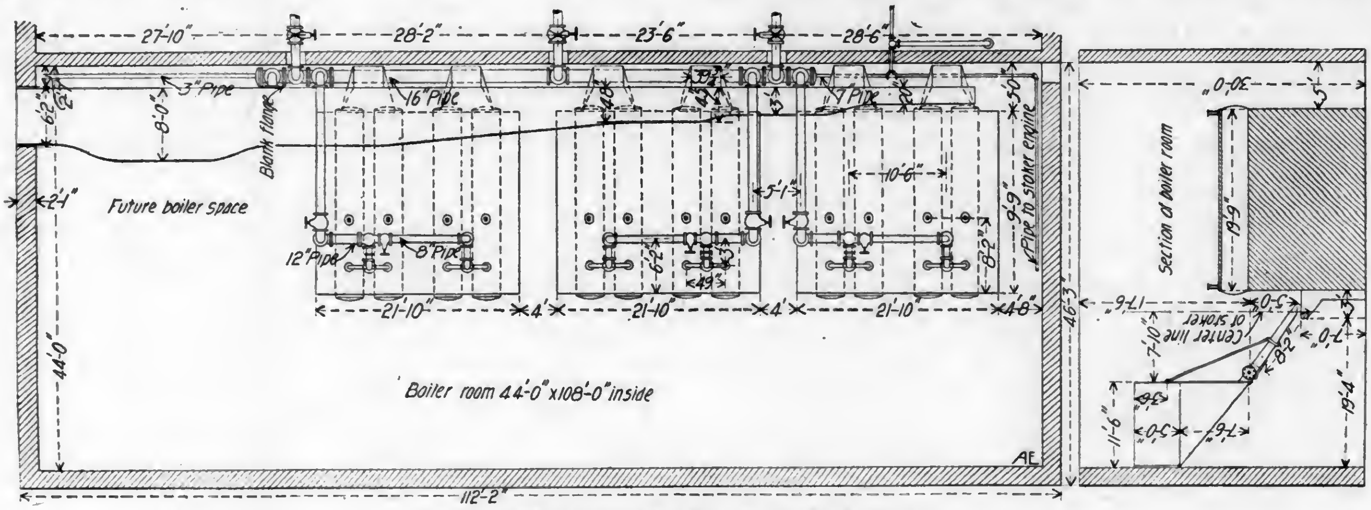
LONG DISTANCE RECORD BREAKING RUN.

Atchison, Topeka & Santa Fe Ry.

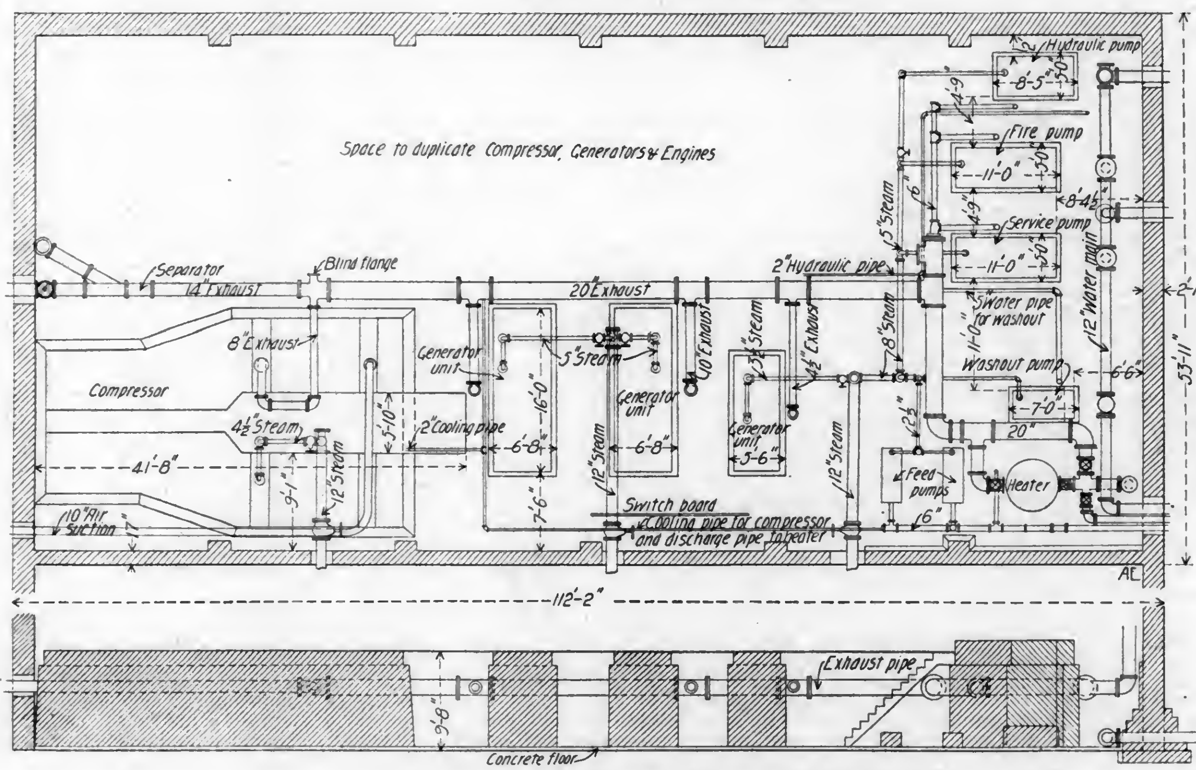
We have received from Mr. J. M. Barr, Third Vice-President of the Atchison road, an official report of the recent long distance record breaking run of a special train conveying Mr. A. R. Peacock and party from Los Angeles to Chicago, a distance of 2,236 miles in 58 hours. Mr. Peacock, who is a director of the Carnegie Steel Co., desired to reach Pittsburgh in time for a directors' meeting. The train left Los Angeles at 10 a. m. on Tuesday, March 27, and the contract provided for his arrival in Chicago on Friday morning in time to take the regular Pennsylvania train for Pittsburgh. He arrived in Chicago at 10 p. m. Thursday night, making the run at a speed of 38.55 miles per hour, including stops, and 41.71 miles per hour, excluding stops. The total delays amounted to 4 hours 24 minutes. The train consisted of the special car "Convoy," weighing 105,300 lbs., and a combination car weighing 43,600 lbs., making a total of 148,900 lbs. Ten engines were required for the trip, and it was not until the train reached Albuquerque that any thought of fast running was entertained, and even then there was no attempt at record breaking, and the special train had to get along as it could between the regular traffic trains as no attempt was made to clear the way for it. The

terminals, distances and speeds are given in the following table:

Terminals.	Distance. Miles.	Average speed including stops. Miles.	Average speed deducting stops. Miles.
Los Angeles to Barstow..	141	36.00	37.60
Barstow to Needles.......	169	37.55	38.55
Needles to Seligman.......	149	36.19	.....
Seligman to Winslow.....	143	27.67	.....
Winslow to Albuquerque.	286	43.22	.....
Albuquerque to La Junta..	347	31.73	34.57
La Junta to Dodge........	202	55.85	57.12
Dodge to Emporia........	227	52.35	55.80
Emporia to Argentine....	109	35.41	39.51
Argentine to Chicago......	463	45.79	49.98
Los Angeles to Chicago..	2,236	38.55	41.71



Improvements, Chicago Shops, C. & N. W. Ry.
Fig. 1.—Boiler Room Arrangement.



Improvements, Chicago Shops, C. & N. W. Ry.
Fig. 3.—Plan of Engine Room, Showing Piping.

This is the fastest run for this distance of which we have record, and it does not by any means indicate the limit for this road. The train made the distance in 12 hours less than the contract called for, and beat the time of the "California Limited" by about eight hours. No instructions were given to make exceptionally fast time, and it was not intended in any sense to be a record breaking train. It is interesting to note that in the 347 miles between Albuquerque and La Junta the train had to climb to a height of 7,492 feet.

CHICAGO & NORTHWESTERN SHOPS AT CHICAGO.

Extensive Improvements.

III.

Power House and Power Distribution.

The general plan of the improvements was given in the March issue, page 92, a description of the buildings in April, page 109, of this journal, and we now present information concerning the power house and power distribution.

Boiler Plant.

The boilers are placed in the north half of the power house. There are six Babcock & Wilcox water tube boilers of 250 h. p. each, arranged with two in each setting, and spare space is provided for two more boilers. The plant now has 1,500 h. p. with room for 2,000. These boilers have vertical headers whereby a

material saving in space is effected. They are equipped with Roney stokers, furnished by Westinghouse, Church, Kerr & Co., and "smokeless" furnaces, which are guaranteed to burn bituminous coal and give full rated capacity with a draft of ⅝ inch air pressure. The arrangement of the boiler room is shown in Fig. 1. On the north side of the building is the track for receiving the coal cars. The coal is unloaded into a hopper below the track from which it is raised by an elevator and deposited into the elevated coal hoppers by means of a horizontal conveyor, the end of which is seen in Fig. 2. The ashes are removed from cars on a depressed track running along the boiler fronts. The coal elevation and conveyor are operated by a 15 h. p. electric motor. There is a 12-in. spout leading from each coal pocket to the corresponding automatic stoker so that all shoveling of coal is avoided after it leaves the car. The boilers carry a pressure of 150 lbs. The arrangement of the piping is seen in Fig. 1. The coal storage capacity is sufficient for 180 tons.

The chimney, which was designed by Mr. G. R. Henderson, is of light colored brick 180 ft. high, including the cast-iron cap. It is lined with firebrick to a height of 75 ft. The core is 8 ft. 6 in. in diameter. The foundation is of concrete laid upon 64

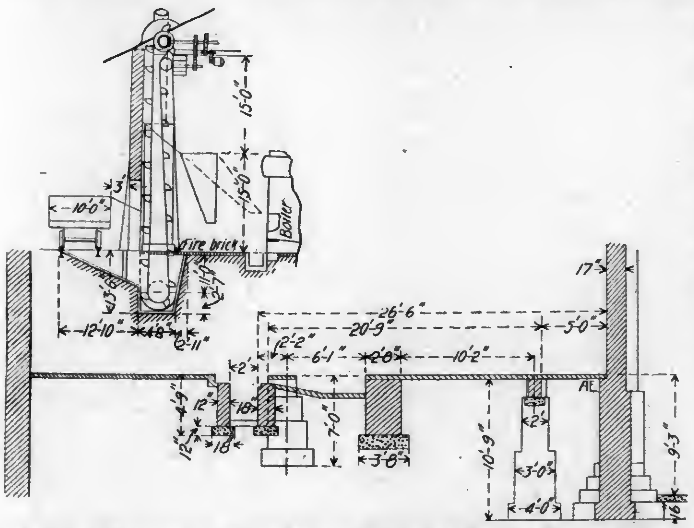


Fig. 2.—Sections in Boiler Room Showing Boiler Foundations and Coal Elevator.

piles. The stack was made large enough to provide for 2,000 h. p., although it will serve at present for but 1,500.

As stated in the preceding article on this subject, from information furnished by the Chicago & Northwestern road, the installation of mechanical draft was taken up in connection with this plant. After carefully considering the design of mechanical draft apparatus with regard to the arrangement of the plant and the necessary height and size of stacks it was decided that three stacks would be required, one for each pair of boilers and that the height should be sufficient to avoid the possibility of sending smoke into the shops, drafting rooms and laboratories, and that the diameters of the stacks should be sufficient for natural draft even when the boilers are forced. This was considered necessary because of the reluctance of the officers of the road to run the risk of a shut-down of one or more boilers by a possible failure of the mechanical draft devices. The depreciation of the smoke fans and steel stacks was placed at about 10 per cent., and all things considered, it was believed that the cost of mechanical draft, if installed under these conditions, would be too close to that of a permanent chimney, which may be expected to last until outgrown without any extensive repairs, to offer any advantages, and at the same time the constant running expense of the fans counted against the mechanical draft. It was estimated that the cost of running the fans would be $340 per year, which capitalized at 6 per cent., would represent $5,600.

Engine Room.

The engine room has two 250 h. p. compound non-condensing engines, driving a pair of 75-kw. generators to which they are direct connected, and a 65 h. p. simple engine direct connected to a pair of 20-kw. generators. The engines were furnished by the Ball Engine Co. They are vertical and arranged with one generator on each side of each engine. This room also contains the Riedler air compressor, feed pumps, fire and service pumps, and a Cookson feed-water heater, which is 112 in. high and 61 in. in diameter, the rating being 1,500 h. p. The pumps are at the right hand end of the room, as seen in Fig. 3. The large engines have 12 and 22 by 14 in. cylinders and run at a speed of 275 revolutions per minute. The small engine has a 9½ by 10 in. cylinder and runs at 360 revolutions. The larger engines are guaranteed to work within 21 lbs. of steam per indicated horse power hour at 150 lbs. boiler pressure, and the small engine to fall below 22½ lbs., the variation in speed to be not more than 2 per cent.

The machinery room is excavated to a depth of nearly 10 ft. and has a concrete floor. The machinery is mounted on foundations located as in Fig. 3, with the air compressor at the left. The plans of this room are exceedingly complete and careful provision has been made for extensions. Space enough remains for the addition of machinery to more than double the present capacity, the open floor space in Fig. 3 being provided for this purpose. The plans cover the steam and exhaust piping for the complete installation so that all possible contingencies have been considered. The exhaust main passes through the center of the building under the floor. It begins with 14 in. pipe and enlarges to 20 in. at the feed water heater. A by-pass is provided at the heater and the steam may be exhausted to the open air or through the steam heating system for the shops. Three 12-in. steam pipes enter the engine room from the boiler room header. These lead to the engines, air compressor and pumps, and they have blank tees for extension to the additional machinery whenever it may be required. The plant may be extended without interfering in the least with the operation of the shops. The piping has swing joints, expansion and contraction being taken up by the threads. Each engine has a separator.

The hydraulic pump in the power house supplies water at a pressure of 1,500 lbs. per square inch, which will be used chiefly for the boiler shop riveters, punches and shears. The accumulator for this pump is located in the boiler shop near the riveter and ingenious mechanism has been devised to start and stop the pump in accordance with the demands made upon the accumulator. This is accomplished by means of a separate pipe conveying pressure from the accumulator to the pump, operating a governing valve at the pump. The distance from the accumulator to the pump is about 500 ft. Soapy water is used in the hydraulic system. The water discharges into an elevated tank, which insures its flow back to the pump for the prevention of pounding and the production of a vacuum in the piping. These pipes are carried overhead, and where they pass between the buildings they will be put into the same casing as the steam pipes.

The water system is served by two underwriters' fire pumps of 1,000 gallons per minute, furnished by Fairbanks, Morse & Co. One of these has a Fisher governor and is intended to maintain a constant pressure of 100 lbs. per square inch. The other pump will be reserved exclusively for fire purposes and will be kept slowly moving at all times. It will be ready to respond instantly upon the opening of the valve. In addition to these there is another pump for washing out locomotive boilers. It is controlled by a Fisher governor and keeps a constant pressure in the washout mains in the round house which will be available day and night.

The air compressor, which is of the Riedler type, was built by Messrs. Fraser & Chalmers of Chicago. It has air cylinders 16 and 27 by 36 in. and steam cylinders 16 and 28 by 36 in. Its capacity is 1,500 cubic feet of free air per minute compressed to 90 lbs. per square inch, and the speed is 65 revolutions per minute, the steam pressure being 150 lbs.

The air cylinders are equipped with Fraser & Chalmers'

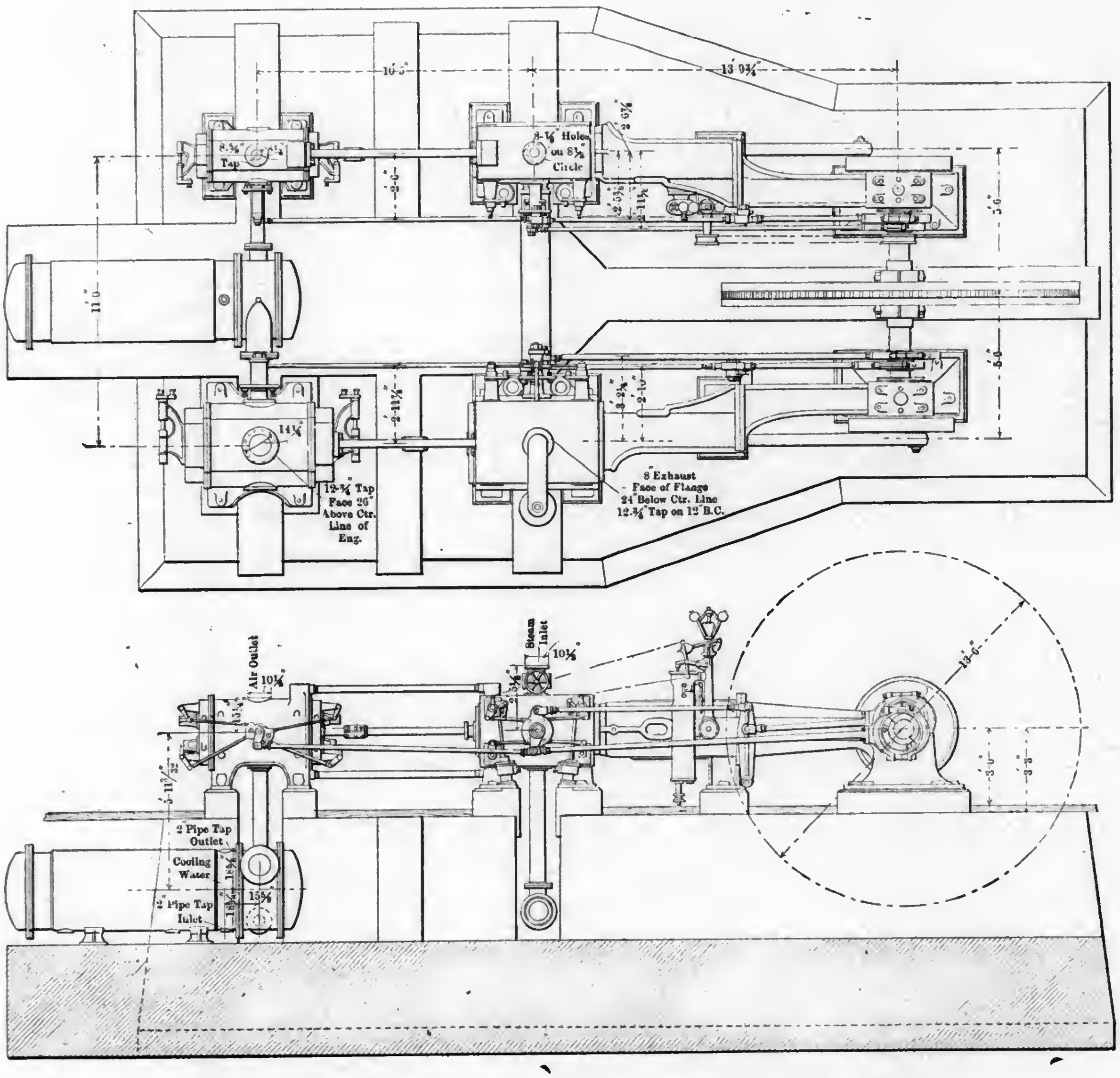
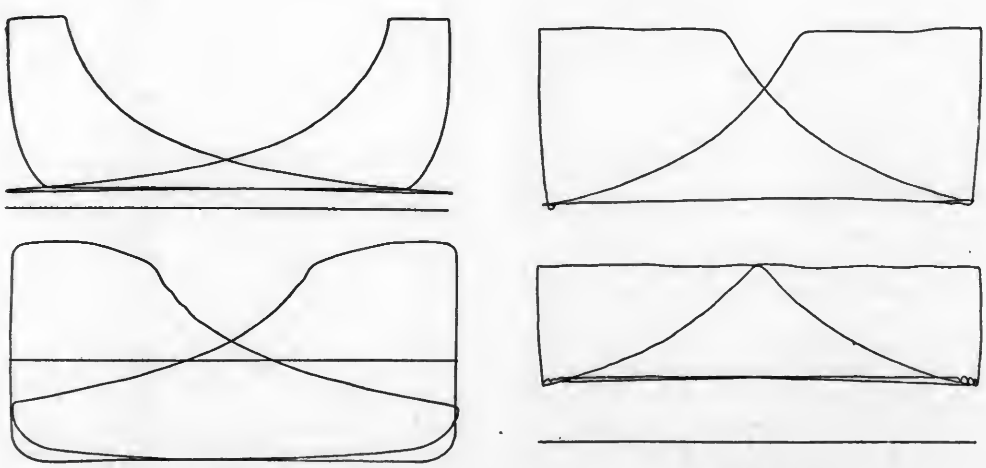


Fig. 4.—Riedler Air Compressor, Built by Fraser & Chalmers, Chicago.



Steam Cards. Air Cards.

Fig. 5.—Indicator Cards from Riedler Air Compressor.

improved form of Riedler positively controlled air valves, the valves being made of forged steel and so arranged as to be easily adjusted when the compressor is in operation. Between the high and low pressure air cylinders is placed an intercooler having 375 sq. ft. of tube cooling surface. The engines are of Fraser & Chalmers' standard Corliss type with steam jacketed cylinders. The speed of the compressor is regulated by a combined steam and air governor, this being so designed that the speed of the compressor is varied to meet the demands for air, the steam governor coming into action only in case the engine speed should increase beyond the maximum desired. To allow the compressor to run at slow speed when but little air is being used, an extra heavy flywheel is provided on the crank shaft. The steam consumption of this compressor, when running at its normal speed, compound, non-condensing, with the steam pressure at the throttle of 150 lbs. per sq. in., and delivering air under a pressure of 100 lbs. per sq. in., will not exceed 58 lbs. of dry steam per 1,000 cu. ft. of free air compressed. Actual air cards taken from a similar type of Riedler air compressors are reproduced in Fig. 5. These cards may be compared with those generally obtained from ordinary makes of air compressors, to show the effect of the Riedler positive valve mechanism. The lost work with the latter mechnism, as shown by the cards, is reduced to the very minimum.

The cooling water for the compressor is returned to the feed-water heater for use in feeding the boilers.

The generators, of which there are six, were all furnished by the General Electric Co., and they are all standard machines. The four larger ones are 6-pole, 75-kw. machines, furnishing 600 amperes at 125 volts. The others, driven by the small engines are 25 kw., furnishing 160 amperes at 125 volts. The generators are connected with a marble switchboard of 8 panels. The light switches are on triple bus bars and the power switches on double bars with 220 volts difference in potential. The lights and motors are on separate circuits, but the switchboard is arranged so that one pair of generators may operate motors or lights or any number of the generators may be operated in parallel through bars and equalizer ties on the switchboard.

The whole area of the engine room may be reached by a hand-power overhead traveling crane of 7 tons capacity, with a span of 49 ft. 3 in., and a travel of 22 ft. 9 in. of the hook.

Power Distribution.

The power required to drive the shops was estimated from indicator diagrams taken from the former steam engines, with proper allowances for the increase in the machinery.

The machine shop, which was formerly driven by a steam engine of about 100 h. p., has four 35 h. p. motors located at different points. Each motor drives an independent section of the main shafting and operates the tools in its vicinity. The shafting in this shop has been in use for a number of years and the tools were grouped in accordance with convenience and economical operation of the shop. It was not considered advisable to disturb the arrangement.

The machine shop annex (see plan, Fig. 8, page 111), has four 20 h. p. motors which were formerly used as generators. These run at 110 volts and each drives a section of shafting 150 ft. long. Two of the motors are placed on the first and two on the second floor. There are 8 motors for running the machine shop, including the annex, and a 10-h. p. motor operates a walking crane in the main machine shop, which runs the entire length of the building. The motors are placed on foundations in the floor and connect directly to the shafting by belts. The machine shop, as originally constructed, did not provide for overhead crane service over the locomotives, except for the lighter parts, and in the original construction of the shops the machinery was belted in such a way as to be out of the way of the light hand cranes over the engines. Eventually this shop will probably be rebuilt and cranes of large capacity will then be installed, but this is not contemplated in the present plans.

The boiler shop has a 20 h. p. motor for the smaller machinery and a set of 14 ft. bending rolls is driven by a 25 h. p. individual reversing motor which operates the rolls and the feed. There are two electric cranes in this shop. The larger one of 50 tons has three motors of 10, 7½ and 5 h. p., while the small one of 5 tons capacity has three of 9½, 5¼ and 1¼ h. p. The transfer table, which serves the machine and boiler shop, has been operated by a 10 h. p. motor. When this table is lengthened and remodeled it will be operated by a 20 h. p. motor.

The tank shop has one 25 h. p. motor for running the machinery, including a wheel lathe, drill press and wheel boring machine. The completed tender work is provided for in this shop. In addition to these there are two 5 h. p. individual motors for a punch and shear. This shop has a 30-ton crane.

Additional power is provided at the two round houses where the turn tables are operated by 10 h. p. motors acting with direct adhesion; at the paint mill, where grinding machinery is operated by a 95 h. p. motor and at the blacksmith shop where a 35 h. p. motor drives fans, bulldozers and bolt machinery.

All of the motors, except those in the machine shop annex, which were formerly used as generators, operate under 220 volt direct currents and the lighting circuits carry 110 volts, including those for the 100-hour enclosed arc lamps. The current is taken to the motors through heavy weatherproof cables carried overhead. The lights are all on three wire circuits. The power circuits are arranged as follows: One three-wire circuit for the 110- volt motors in the machine shop annex; one two-wire circuit for the blacksmith, carpenter and tank shops; one two-wire circuit for the machine shop, one for the coal conveyor in the boiler house; one for the paint shop motor; one for the cranes in the boiler and tank shops; one for the two car shop transfer tables; one for the round house turntables and one for the locomotive transfer table.

This work involved a large number of difficulties. It is not offered as a model establishment, but as an excellent example of the application of electrical distribution in extending an old plant. One fact which stands out boldly in an examination of this problem is the necessity for providing for improvements and extensions in the original construction of shops. Another is the great importance of crane service and providing for convenient handling of work and material.

Mr. Robert Quayle, Superintendent of Motive Power of the road, has been exceptionally fortunate in having the assistance, first of Mr. W. H. Marshall, now Superintendent of Motive Power of the Lake Shore, and afterward that of Mr. G. R. Henderson, in the planning and execution of this work, and that of Mr. F. M. Whyte, now Mechanical Engineer of the New York Central, and his successor, Mr. E. B. Thompson.

Mr. Sidney H. Wheelhouse, formerly Sales Agent for the Chicago Pneumatic Tool Co., has been appointed Second Vice-President of the Standard Railway Equipment Co., in charge of the pneumatic tools sales department, for the west, with offices at 412-414 Lincoln Trust Building, St. Louis, effective May 1st, 1900.

A remarkable trip of an ice breaking steamer on Lake Baikai, Siberia, is recorded by "Engineering News" as having been made February 10. The distance of 80 miles through ice 31 inches thick was made in 12 hours.

The Lehigh Valley Railroad has ordered three locomotives from the Baldwin Locomotive Works for its "Black Diamond Express." These will be somewhat larger than the engines which are now handling this train. They will have 20 by 26-inch cylinders, 80-inch drivers, 200 pounds boiler pressure, 108 by 90-inch fireboxes, 326 2-inch tubes, 15 feet 6 inches long. 4,500 gallons tank capacity, and they will weigh 157,000 pounds each, of which 90,000 pounds will be on the drivers. The wheel base is increased by the large drivers, but otherwise the locomotives will be the same as the present engines.

(Established 1832)

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Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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Sir William Preece recently defined mathematics as the shorthand of thought and the purest form of logic; experiment as the handmaid of observation; and measurement as the instigator of accuracy and precision. He is thus quoted in "Engineering" and in these few words has framed a pure ideal of technical education.

Methods of handling scrap material from car and locomotive shops have been greatly improved during the past few years, and a great deal has been done to increase the value of reclaimed material. On many large roads there is room for further improvement, one suggestion being in the direction of managing the scrap on a wholesale or manufacturing basis. In large plants, including both car and locomotive shops, the scrap is generally cut up and handled in several places. There seems to be a decided advantage in taking all the scrap material to one place which is provided with tools necessary for cutting it up and with facilities for storing the good material in usable form, the object being to concentrate this material to such an extent as to permit of issuing it in carload or half-car load lots, and placing prices upon it. The mere fact of the price being a possibility places this work upon a manufacturing basis than which there is no more important element tending in the direction of businesslike management of shop matters.

The usual attachment of tender tanks to the frames by means of bolts at each of the four corners was never secure or satisfactory, and it is much less so with the great increase in capacity whereby from 6,000 to 7,000 gallons of water and 10 to 12 tons of coal are carried. Something is needed to prevent the tank from sliding forward and crushing into the cab as a result of collisions. With the newer forms of tanks there is no difficulty in placing a substantial member of the frame in such a position as to hold the tank securely against such movements.

Experiments recently made with a locomotive with a wide firebox have shown very nicely that the grate area which is suitable for one quality of coal may be entirely wrong for a different quality. An engine with a grate area of 70 square feet when used in fast passenger service was taxed so nearly up to the limit of its boiler capacity that the entire grate area was needed even with the best of coal, which was anthracite. When running in less exacting service the grate was blocked off at the front end so as to shorten it one and one-half feet, with excellent results with the same coal as before. When an inferior grade of coal was tried on the slower and lighter trains the whole grate was needed again. This shows, conclusively, the advantage of building grates which are larger than are required for the best coal and comfortable conditions in order to provide for more exacting trains and less effective fuel. Adjustability of grate area seems to be desirable for the same reason that recommends adjustable cut-off, to meet varying requirements of work to be done.

That the comparison of operating statistics of different roads working under widely different conditions is very misleading and unfair is generally understood by motive power officers. It is not so well understood by other officials, however, for presidents and general managers not infrequently cause their motive power superintendents a great deal of trouble in trying to show why they do not make as good records as their neighbors and others. Comparisons would be of the greatest value if they could be made with intelligence and fairness, but methods now in use are not satisfactory. The train-mile is not fair because it gives no idea of the work done. The ton-mile basis is better, but unless the grades and speeds are known even this cannot be used to compare different roads. Not only the speeds and grades, but also the character of the locomotives, the location of water stations, character of the water and general climatic conditions affect the results. Furthermore, the methods of different roads in computing train mileage are by no means the same. It may or may not include the mileage of double headers, light engines, switching, pushing and work train engines. It may or may not include the weight of the engine in the tonnage. In spite of these difficulties the fact remains that comparisons will be made. It is therefore important that all roads should agree upon uniform methods of reporting statistics. The Western Railway Club did wisely to send a copy of the proceedings of its recent meeting, in which this question was the subject of discussion, to the Association of Railway Accounting Officers and the American Railway Association committee on statistical information. This is a much more serious question than it at first appears. We know of a case where the head of an important department and several of his assistants were changed chiefly because locomotive repairs were not reduced from four to three cents per mile, as required by the new management. This arbitrary figure was fixed because it had been attained on the road from which the new management had come. It was developed afterward that the higher cost of repairs on this road was accompanied by correspondingly greater ton mileage. Whatever else is accomplished, the train or engine mile basis for statistics in comparing the work of different roads will be discarded when its misleading character is understood.

GOOD FIRING IS THE BEST SMOKE PREVENTER.

Satisfactory methods of burning soft coal without smoke have been sought for for over a hundred years. We say satisfactory because it has been repeatedly demonstrated that smokeless consumption can be accomplished, but when special devices are employed there is likely to be some mechanical defect which is troublesome, if not fatal.

A valuable contribution to the literature of the subject is the recent report of a committee of the Western Railway Club, Mr. G. R. Henderson, Chairman, which was appointed to consider what is being done toward improvement in this respect on locomotives in Chicago, and to indicate, from a careful study of various methods, the probable best direction for future development. The various mechanical devices investigated by the committee were sometimes heartily endorsed, sometimes equally strongly condemned by those who have used them. It is clear that these are not considered promising in the ultimate solution of the problem. Wider fireboxes are looked upon with hopefulness, but "only certain types of engines permit of this arrangement, and its use is limited."

The composition of coal has much to do with this question. Those high in fixed carbon and low in volatiles, like the Pocahontas of Southwestern Virginia, produce very little smoke. This coal contains from 75 to 80 per cent. of volatile matter, but Illinois coals, with about half as much fixed carbon and twice as much volatile matter, represent the real problem. It is not made easier by the fact that many roads are obliged to use a large number of coals which require different treatment in accordance with their composition. One road running into Chicago draws its supply from more than 100 mines, and at times it is necessary to get along with very inferior fuel. This indicates the necessity for flexibility in any system in order to adapt it to various conditions.

This committee gives special prominence to the skill of the fireman and to co-operation between the engineer and fireman. The best results in smokeless firing are obtained on a road which uses no devices whatever except the brick arch. While air compression above the fire is held by some to be effective, it is generally considered as a smoke diluter rather than a consumer. There is strong support for the practice of drawing the air needed for combustion through the fire instead of introducing some of the air over it and making use of the brick arch for mixing the gases and forming a combustion chamber.

There is, apparently, nothing so effective in smoke prevention as skillful firing, and the general opinion seems to be that a good fireman can accomplish more without special devices of any kind than an indifferent fireman with them. It is necessary for the engineer and fireman to understand each other. The fireman should be informed in advance of every change which the engineer is to make, so that the fire may be kept in readiness for the changes. There is a good field for expert or "traveling firemen" in the education of the men. The practice of firing five or six scoopfuls at a time and resting between, should give place to light and frequent firing, the door being left open a little on the latch to admit air enough to burn the fresh distillates, and then closed, unless a damper is provided in the door. If a stop is to be made when green coal is on the fire, the blower should be applied before the steam is shut off, and as soon as the throttle is closed the door should be opened slightly on the latch and the blast of the blower reduced sufficiently to prevent black smoke and to keep the pops from blowing.

This report states in effect that there is no panacea for smoke; that the necessary treatment varies with the quality and composition of the coal; that the matter is largely in the hands of the fireman and engineer, and that the firing should be done in such a way as to avoid chilling the surface of the fire by excessive increments of fuel, the method of adding fuel being to scatter it in thin layers and admit sufficient air to consume the hydrocarbons which are distilled off in large volume as soon as the fresh coal drops upon the hot fire.

The superimposed turrets of the new battleship "Kearsarge" have been put through firing tests which are reported to have been satisfactorily met. The advantages of the construction are a heavy concentration of fire, good protection for the ammunition hoists for the 8-inch guns of the upper turrets, and a great saving in weight. There is also no interference in the gun fire. The trial tests showed that the mechanism worked well, but nothing but a trial in actual battle can show the effect of gun fire upon the turrets. A single successful shot may disable two 12-inch and two 8-inch guns.

The annual report of the Commissioner of Patents shows a surplus of $113,673 for the operations of the year 1899. The total balance to the credit of the Patent Office at the beginning of this year was $5,086,649. It is well known that the present quarters are too small and that a fireproof building for the records is greatly needed. The fact that the office is self-supporting is a good reason for supplying these deficiencies, entirely aside from the great value of the records. The total number of applications for 1899 was 41,443 and present indications point to a breaking of the record for the current year. The commissioners appointed by Congress to revise the laws relative to patents have submitted a preliminary report and will soon present a complete report. At that time Congress should be urged to act for the improvement of the Patent Office and the revision of the statutes relating to trade marks.

The idea of lectures delivered by the best non-resident engineers and men of authority that the country affords, to engineering students, is one of which many of our technical schools and colleges are availing themselves. The following schedule for the year 1899-1900 has been sent us by the University of Illinois, six lectures of which have already been delivered: Mr. Walter B. Snow of the B. F. Sturtevant Company, Boston, Mass., on "Mechanical Ventilation and Heating." Mr. H. G. Prout, editor of the "Railroad Gazette," on "Engineers and the Railroads." Mr. A. V. Abbott, Chief Engineer of the Chicago Telephone Company, on "Electrical Highways." Mr. F. W. Willcox of the General Electric Company, Harrison, N. J., on "The Evolution and Economic Use of Incandescent Lamps." Mr. F. H. Newell, Hydrographer, United States Geological Survey, Washington, D. C., on "Hydrographic Work of the United States Geological Survey," and on "Reservoir Surveys Along the Gila River, Arizona." Mr. W. A. Layman of the Wagner Electric Manufacturing Company, St. Louis, Mo., on "Transformers in Modern Electric Power Transmission." Prof. R. B. Owens, McGill University, Montreal, Canada, on "Most Recent Developments in the Applications of Electricity."

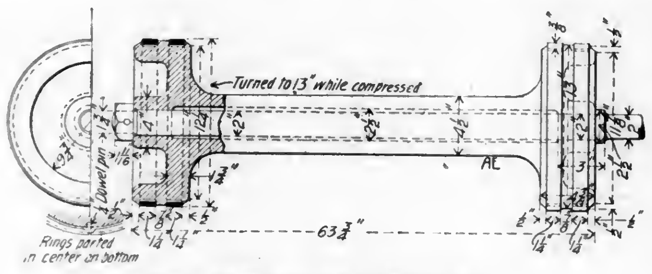
The Massachusetts Institute of Technology has at present two holders of traveling fellowships studying architecture in Europe. Mr. H. W. Gardner, an instructor in the department of architecture, is to pass a year mainly in Italy and Greece. In Italy he is giving much study to its landscape architecture, in preparation for the part he is to take on his return in the courses of Landscape Architecture already so well started at the Institute. Mr. G. P. Stevens, holder of the other fellowship, after traveling and working with Mr. Gardner, is now in Pascal's atelier in Paris, preparing to enter the Ecole des Beaux Arts at the next examination. Mr. Stevens' skill in draftsmanship at once brought him into notice, and he writes of his good fortune in being chosen by the strongest man in the atelier, and one of the strongest men in Paris, to help him in a Beaux Arts competition for which only five men were invited. The competition is to use the grounds now occupied by the Exposition buildings after the fair is over, for a huge system of public baths.

The United States will stand at the head of the coal producing countries of the world at the end of the current year if the estimated output of this year is realized. In the past 30 years Great Britain has not doubled her output, while that of the United States has increased almost seven fold in this time.

PERFORMANCE OF THE CLEVELAND LOCOMOTIVE.

Intercolonial Railway.

A system of dual exhaust applied by Mr. L. J. Todd in England was illustrated and described in our issue of September, 1897, page 311, because of its interest as a suggestion for overcoming some of the cylinder condensation in locomotives due to the use of the same passage for the entrance and exit of steam used in the cylinders. An experiment in the same direction



Piston Valve—Cleveland Cylinder.

has been tried on the Intercolonial Railway of Canada with the Cleveland arrangement of cylinders which have been in use on that road for the past nine months and a record of which we now present, showing the performance of the engine when compared with other engines on the same road running in similar service. The record is not stated in ton miles, but we are assured that the service is comparable.

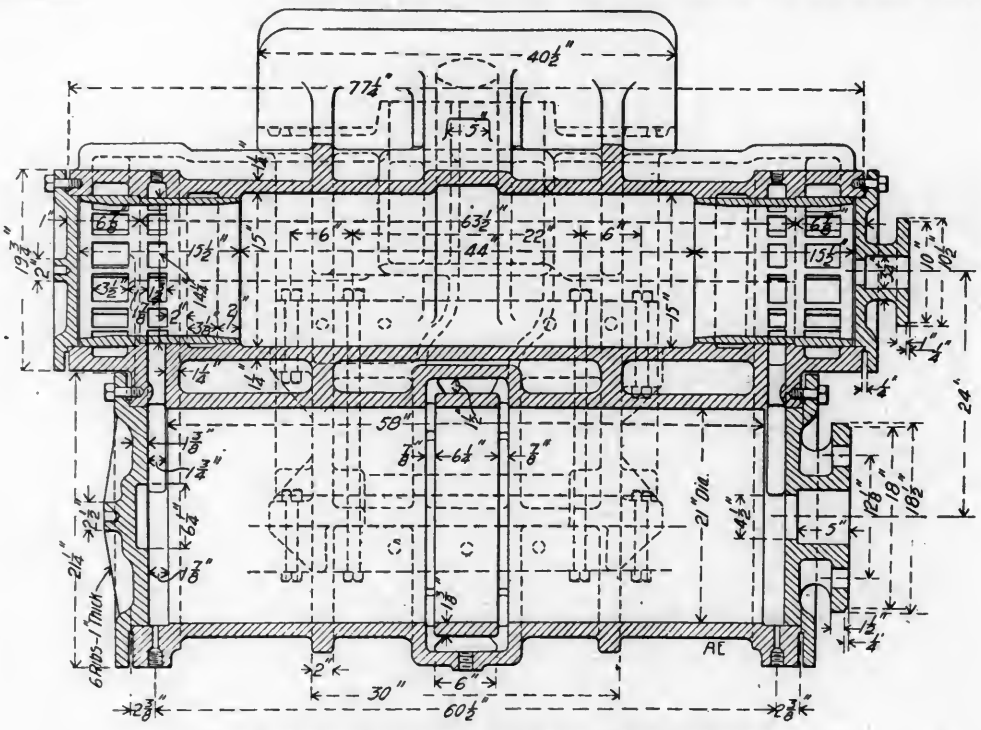
The Cleveland engine, No. 288, has cylinders 21 in. diam. x 28 in. stroke and 56 in. driving wheels, and is one of a lot of twenty consolidation engines built by the Baldwin Locomotive Works for the I. C. R.; the other nineteen engines being fitted with Vauclain compound cylinders, 15½ and 26 by 28 in. and the same size driving wheels. The proportions of cylinder power of the Cleveland and Vauclain engines were computed by the builders to be equal. The steam pressure in both types and the weight on he drivers is the same in all cases, viz., 147,000 lbs., but the Cleveland engine has 21,900 lbs. on the truck which is 4,600 lbs. more than the compounds.

Comparative statement of the performance and consumption of coal, of the compound consolidation, Cleveland consolidation and 10-wheel freight locomotives, for the months of October and November, 1899:

October, 1899.	19 Compounds.	Cleveland. Locomotive.	12, 10-Wheel Freight Locomotives.
Train miles	51,243	2,202	22,406
Engine miles	59,010	2,662	29,405
Car miles	1,432,470	64,833	424,269
Tons coal consumed	2,665	121	1,138
Average cars per train	27.95	29.44	18.94
Av'ge lbs. coal eng.-mile	101.16	101.82	86.69
Av'ge lbs. coal car-mile	3.62	3.46	4.58
November, 1899.			
Train miles	56,128	2,069	26,742
Engine miles	64,167	2,257	33,249
Car miles	1,490,370	55,131	488,592
Tons coal consumed	3,119	111	1,440
Average cars per train	26.55	21.65	18.28
Av'ge lbs. coal eng.-mile	108.88	110.16	97.01
Av'ge lbs. coal car-mile	4.10	4.13	5.31

A tabulated statement sent us by Mr. Cleveland, given above, shows the totals and averages of the performance of 19 Vauclain, 12 10-wheel freight engines with 18 x 24 cylinders and 57 in. drivers, and engine No. 228, consolidation fitted with the Cleveland cylinder, for the months of October and November, 1899, during which time the several engines were hauling practically the same class of freight, under conditions not specially favorable to the Cleveland. It will be noted that the coal consumption for the Vauclain and Cleveland engines is practically the same, both being considerably below the ordinary simple engine and all of the engines were in good condition. A statement given in the accompanying table shows the results of a test made for speed with a full load, going up grades varying from 0.89 per cent. to 1 per cent. From the sectional views of the cylinder piston and valve there will be no difficulty in understanding the main points of deviation from the ordinary simple locomotive cylinder. It will be noticed that there are two annular ports running round the barrel of cylinder, 6¼ in. apart, dividing at the central vertical line.

The piston passes these ports alternately, releasing the steam after it has done its work, and exhausting between the two discs of the piston through an exhaust independent of the supplementary or ordinary valve exhaust. The admission, or ordinary valve, is of the piston type, taking the live steam from

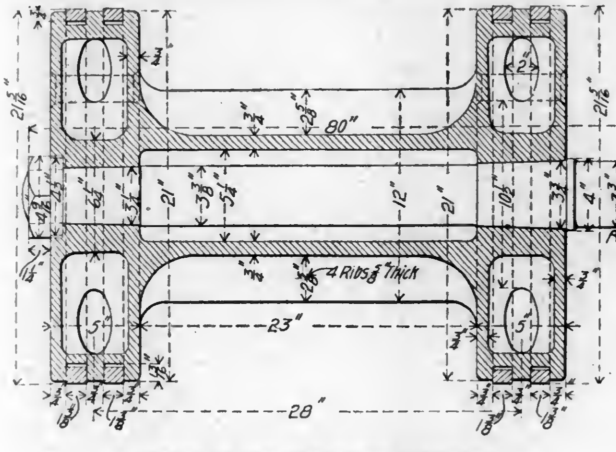


The Cleveland Cylinder and Piston Valve Chamber.

the intermediate space between the two valve discs. The valve serves for an entirely independent adjustment of admission of steam irrespective of the main exhaust, and regulates the compression of what steam may be left on the return stroke.

The release of steam through each piston exhaust and valve exhaust is separate and independent until it gets to the upper part of the exhaust pipe; the piston exhausts combine, in the central chamber, and are supposed to act as a draw or induction on the valve exhaust, the valve exhaust issuing from the annular space. The space between the two discs forming the cylinder piston is filled with steam at a temperature nearly equal to that of the initial exhaust, and this is believed to keep the walls of the cylinder in a more favorable condition than is the case in the ordinary cylinder.

The Cleveland cylinders apparently enable the engine to work very smoothly and they avoid the excessive cushioning found in high-speed locomotives. That this is so has been proven in engine No. 228, which has been running an express train, the "Maritime Express," on scheduled time for the last two months, making 156 miles on a double trip daily, and has at times made up in time as much as 25 minutes on



Piston of the Cleveland Cylinder.

the single run of 78 miles, and this with everything working perfectly cool. This performance for a consolidation engine with 56-inch drivers is exacting, and speaks well for the free running qualities of the engine. The schedule for the 78 miles is 2 hours 18 minutes.

It is claimed for this system of single-expansion engine that there is a direct saving in quantity of steam used at a given pressure to do a given amount of work. This, of course, means less coal consumption and other advantages, owing principally to the rapid exhaust keeping the temperature above that of ordinary single-expansion engines, thus allowing a greater range of expansion, and at the same time this rapid exhaust very materially reduces the back pressure. This, of course, is a direct gain. The clearance is much less than in the ordinary cylinder, and taking into consideration that the greater the expansion the greater the loss by clearance, one can easily understand how this cylinder can compete with the compound system. Also as the great bulk of the exhaust steam passes

Test for Running Time, Made November 2, 1899.—Weight of Train, Cars only 1,234 Tons; Number of Cars, 38. Baldwin Compound, $\frac{15\frac{1}{2}\text{ in.}}{26\text{ in.}}$ × 28 in. Cleveland Simple, 21 in. × 28.

Name of Place.	Engine No. 215.				Engine No. 228.			
	Time of Day.	Time in Minutes.	Totals of Times.	Water.	Time of Day.	Time in Minutes.	Totals of Times.	Water.
Started from Moncton	11:52½			Water used, in gallons, for total running time, 1,920 gallons.	13:33½			Water used, in gallons, for total running time, 1,655 gallons.
1st mile post........	12:08½	13			13:39	5½		
2d " "	12:12½	4			13:42½	3½		
3d " "	12:15½	3			13:45	2½		
4th " "	12:18¼	2¾			13:48	3		
5th " "	12:23	4¾			13:52¼	4¼		
6th " "	12:27½	4½			13:57	4¼		
7th " "	12:30	2½	34½		13:59¼	2¼	25¾	
Stopped Berry's Mill...............	12:31½				14:00½			
Started from Berry's Mill	12:34				14:30			
1st mile post........	12:38	4			14:33	3		
2d " "	12:46	8			14:38½	5½		
½ mile to top hill...	12:50	4	16		14:41¼	2¾	11¼	
Total running time.			50½ min'ts.		Total running time		37 minutes.	

Notc.—Waste of water due to using injectors not taken into account.

through independent passages, the live steam entering through short passages has a good chance to do its initial work without being cooled on its way.

The cylinder is designed to have a perfect drainage, and on referring to the section of the cylinder it will be found that there are no pockets for the accumulation of water. This is a point of importance lost sight of in most cylinder designs.

In this record it must be considered that the Cleveland engine is compared with the average of 19 compounds. There seems to be good reason for believing this engine is superior to an ordinary simple engine and it deserves further trial.

PNEUMATIC TOOLS BEFORE THE INSTITUTION OF MECHANICAL ENGINEERS, ENGLAND.

The meeting of the Institution of Mechanical Engineers just past was devcted to the discussion of Pneumatic Tools and Power Hammers. The speeches were made by the following gentlemen:

Mr. Simpson, of Pimlico; Mr. Ivatt, Locomotive Superintendent of the Great Northern Ry at Doncaster; Mr. John Fielding, of Gloucester; Mr. B. Martell, of Lloyd's Registry of Shipping; Mr. Marriner, Mr. Alfred Hanson, of Messrs, Shone & Ault, and Mr. J. W. Duntley, President of the New Taite-Howard Pneumatic Tool Company of London, and also President of the Chicago Pneumatic Tool Company of Chicago.

Mr. Duntley, in his remarks, said that he had been making pneumatic tools for five years past. Perhaps it would give the best idea of popularity in the United States if he stated their output. During the first year they were in business they made 100 machines, all told. Last year they averaged 800 per month. At the present time they were building new works, and expected to double their production. By aid of these tools, Messrs. Cramp, of Philadelphia, had been able to overcome the results of a strike of 7,000 men, and in one ship they had just built all the rivets were closed by pneumatic machinery; as a consequence, Messrs. Cramp had given a duplicate order for the pneumatic machines. A proof of the superiority of pneumatic riveting was given in the fact that the rivets themselves were ⅛ inch longer than for hand riveting, and this additional metal had to be closed into the holes, thus showing that the latter were better filled by the use of the pneumatic riveter than by the hand hammer. Another proof was given in the cutting up of work. With ordinary hand riveting, if the heads of the rivets were cut off, the shank would fall out from the holes in the plates, but when the rivets had been closed by the pneumatic machine they had to be driven out.

The speaker himself was not a skilled operator, but in a contest in Germany he had beaten the hydraulic riveter; ninety-seven per cent. of the railroads in the United States were using these tools, and the speaker gave a large number of instances in which air machines were used for superseding hand work. In the United States Government shipyards they used the pneumatic hammer for scaling ships, and it was found to be a great improvement on the old method. Another use for pneumatic machinery was in breaking up iron or steel vessels. They had what was called a "biter" or "nibbler," which chewed off the heads of the rivets in place of cutting them by chisel and hammer. New uses were constantly being found for compressed air; in chipping stone work there had been found to be a saving of $9.00 a day, a rimer did the work of 22 men, and lately he had seen a freight car painted by compressed air in seven minutes. In this country we were in a position to appreciate what had already been done in America in the introduction of compressed air machinery. It was not always easy to get a new thing introduced, and it might be interesting to state that he had worked two years with Cramp's before he could persuade them to give him an order.

Mr. Churchward, of Swindon, said he would like to ask Mr. Duntley a question as to the stay-bolt biter. They had had one at Swindon for some time, but could not get it to work; the claw would not take hold for some reason. Mr. Duntley, in his reply, said that the action of this machine depended on the shape of the claws, and this, again, depended on the nature of the work to be done. The claw must be so arranged as to bite in. Mr. Duntley further stated that he was about to proceed to Russia to arrange for a large installation of pneumatic machinery in that country, and on his return he would be pleased to go down to Swindon and put the machine right. Mr. Churchward further remarked that he did not wish it to be understood that he made any complaint, as the pneumatic machines did their work well, and whatever repairs might be needed were well paid for in the total result.

It is officially announced that on Saturday, April 28, 1900, the office of Purchasing Agent of the Lehigh Valley will be moved to the Taylor Building, 39 Cortlandt Street, New York, also the office of Chief Engineer will be moved to the Havemeyer Building, 26 Cortlandt Street, New York.

Mr. Charles E. Rettew, Master Mechanic of the Pennsylvania division of the Delaware & Hudson, has resigned, after 15 years' service.

THE WESTINGHOUSE FRICTION DRAFT GEAR.

The Construction and Operation in Detail.

The very rapid development of cars of large capacity and the great increase in power of locomotives have left the ordinary forms of draft gear far behind and heavy trains are frequently hauled with the draft gears on a large number of the cars stretched out so that the springs are solid, the spring capacity being entirely exhausted. The train then resembles a chain with practically no elasticity except that of the structures of the cars themselves.

The strains that the couplers, draft rigging and car framing are subjected to when this condition prevails cannot be measured, and are only limited by the elasticity and yielding character of the structure of the car and its draft attachments. While cars were light and all built of wood (a very yielding material) the strains imposed were tolerable, and by good design, care in the selection of materials and good construction, durable cars were obtained. The advent of the heavy steel car has radically changed the amount of elasticity obtainable and, consequently, enormously increased the strains upon draft rigging, without considering the further increase due to larger and heavier locomotives. It is difficult to get room for sufficient spring capacity to overcome this difficulty, nor is it desirable to do so, for any increase in spring capacity alone is unavoidably accompanied by a corresponding increase in recoil, the effect of which is more severe upon the draft rigging than the direct stresses with the lighter springs would be. If the result upon the draft rigging, when a train with ordinary draft springs is forcibly bunched, as in passing through a sag, is considered, it will be seen that the amount of force put into such springs, in the compression produced by the cars running together or "bunching," is practically all given out again in recoil as the train is stretched; furthermore, the amount of such recoil is added to the strain imposed upon the draft rigging by the locomotive. It is well known that under exactly such and similar conditions are trains most often parted when fitted with the ordinary draft-spring capacity and locomotive power. How disastrous will be the results of largely increasing the ordinary draft-spring capacity in addition to the employment of more powerful locomotives, can only be conjectured, but that it will necessarily be great cannot be doubted. The purpose of the Westinghouse draft gear is to furnish a moderate spring capacity and a gradually applied and automatically released resistance, capable of absorbing all of the stresses and shocks likely to be imposed upon it, in either pulling or buffing, and to apply this resistance without a damaging recoil, the recoil being only that due to a free spring capacity much less than that now in general use, while the resistance to pulling and buffing stresses of this form of draft gear is over six times as great as that ordinarily used. To make the operation of the device clear requires an exhaustive description, but the device itself and the great importance of improved draft gear justify it.

Description.

A view of the complete draft gear is shown in Fig. 1 and the relations of the parts to the underframe of the car were shown on pages 88 and 89, last month. The frictional device is placed within the yoke and between the followers, in the usual manner. To accommodate the increased diameter the yoke is widened, and when attached to the standard M. C. B. coupler, filling pieces are used, as shown in Fig. 15. Several of the roads have adopted a coupler with the back end built up as shown in Fig. 1, which makes a much simpler arrangement.. The inner follower plate, A, receives the pulling stresses from the yoke end, the outer follower transmits them to the draw-bar stops and to the car framing. In the common form of draft gear the spring resistance is interposed between the follower plates; that is, the pulling and buffing stresses tend to reduce the distance between the follower plates and these are resisted by the springs which tend to hold them apart. This friction draft gear, in which springs play an important part, acts precisely on the same principle but the resistance of the springs is supplemented by vastly greater (about six times as great) frictional resistances which tend, both in pulling and in buffing, to prevent the follower plates from approaching each other. The way in which the frictional resistances are called into action, by the motions of pulling and buffing, and the manner of their release will command the admiration of those who follow this description.

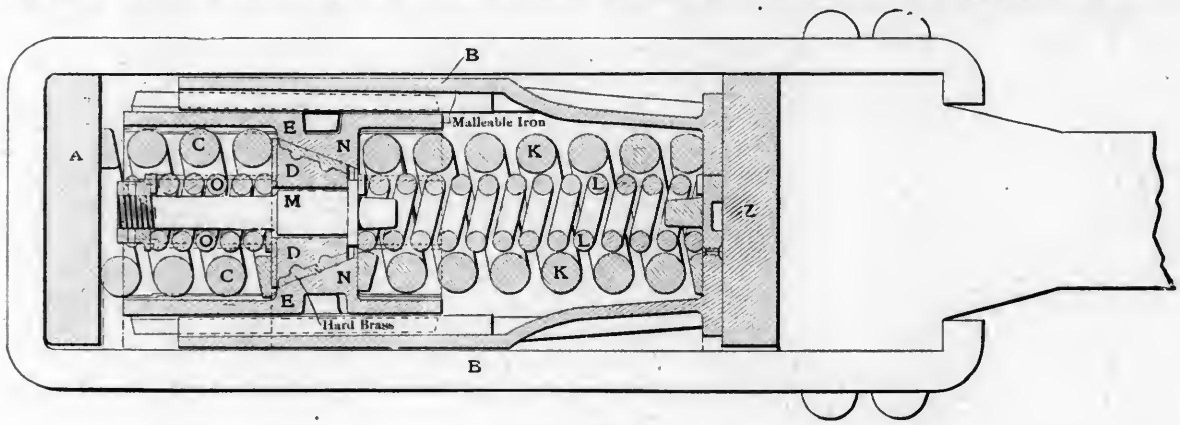


Fig. 1

Bearing against the follower plate, A, is a spring, C, the other end of which bears against a wedge, D, made in the form of a frustrum of an octagonal pyramid with hard brass facets, as shown in Fig. 1.

Surrounding the wedge are four pairs of malleable-iron segmental carriers, E, having inclined bearing surfaces, N, of the same angle as the wedge, as shown in Figs. 2, 3, 4, 5 and 6. These segmental carriers, E, have a central longitudinal rib cast upon them to strengthen and guide them. These ribs fit the grooves, F, in Fig. 9, loosely.

The other grooves of the frictional cylinder, Fig. 9, are filled by the hardened wedge bars, G, Fig. 7. The shape of these wedge bars is seen in Figs. 7 and 8. They rest upon the segmental carriers, E, as shown in the sectional views of Figs. 11 and 14, with the small inwardly projecting portions, marked H, in the lower view of Fig. 7, resting in cavities in the carriers, E. It is clear that if the carriers, E, are moved longitudinally to the right or left, the wedge bars, G, must move with them. The function of the preliminary spring, C, Fig. 1, is to force the wedge against the inclined surfaces, N, of the segmental carriers, and also to absorb the ordinary pressures on the draw bar due to the movement of the train. When the apparatus is placed in the yoke this spring is under a slight compression, which insures the parts being held tightly in position, thus preventing foreign substances from lodging between the bearing surfaces. The auxiliary preliminary spring, O, Fig. 1, gives additional pressure on the wedge. The main release spring, K, is used for returning the segmental car-

Fig. 2

Fig. 3

Fig. 4

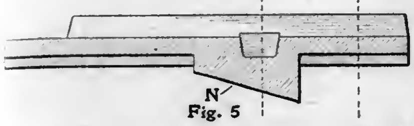


Fig. 5

Fig. 6

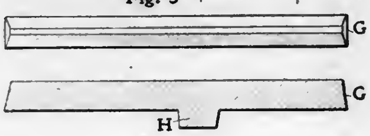


Fig. 7

Fig. 8

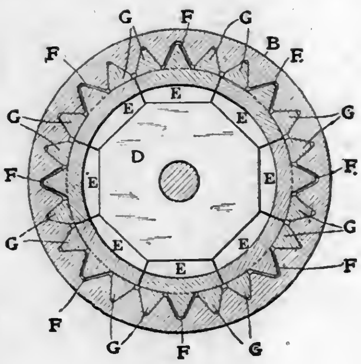


Fig. 9

riers and wedge bars to their normal position after the force to close them has been removed, and it also gives additional capacity to the device. The function of the auxiliary release spring, L, is to provide a sure release of the wedge from the segmental carriers, and it also increases the capacity of the device. The function of the release pin, M, is to relieve the pressure of the auxiliary release spring, L, against the wedge, when the device is being closed.

Operation.

When, either in draft or in buffing, the stress upon the draw bar moves the follower plates, A and Z, Fig. 1, toward each other, the preliminary spring, C, is compressed, and if the pressure so applied is less than would be required to force the follower plate, A, against the release pin, M, the segmental carriers and wedge bars remain at rest, which insures against wear upon the frictional surfaces during the ordinary movement of the train. When the stress is sufficient to force the follower, A, against the ends of the segmental carriers, it will have forced the release pin, M, which projects slightly above the segmental carriers, toward the closed end of the cylinder, thereby relieving the pressure of the auxiliary release spring against the small end of the wedge. In this position the force necessary to compress the springs, C and O, is exerted against the large end of the wedge, and by the inclined surfaces it is transmitted through the segmental carriers to the wedge bars. A further increase of force against the follower plate, A, brings the segmental carriers and wedge bars into action, and in so doing the force exerted by the wedge upon the wedge bars produces friction between the wedge bars and the V-shaped grooves of the cylinder (which is tapered toward the closed end). The traverse of the wedge bars is completed when the follower, A, comes in contact with the cylinder, the release springs, K and L, having been compressed to about 80 per cent. of their capacity. During the movement of the wedge bars in the cylinder grooves the force exerted upon the wedge by the preliminary springs (about 20,000 pounds) remains constant, as their action is limited by the follower, A, bearing on the segmental carriers; the increased frictional resistance being due to the taper of the cylinder.

Upon the removal of the pulling stress at the coupler, the springs, C and O, are restored gradually to their normal size. The preliminary release spring, L, then pushes the wedge back and away from the segmental carriers, which it can do on account of the carefully studied angle of the facets, and in this condition the main release spring, K, bears upon the projections, N, of the segmental carriers and tends to press them to the left, which, when accomplished, will withdraw all of the wedge bars from their locked positions in the grooves at the small end of the cylinder. This constitutes a complete release of the friction device.

The carriers, E, are arranged in pairs with interlocking outer ends, as shown in Figs. 2 and 3, in order to prevent them from being put together in wrong order. Each carrier carries two of the loose wedge bars and the slots in the carriers in which the lugs of the wedge bars rest are of different lengths. In a set of two bars the first lug fits the slot, the second has 1/16 inch play, the third ⅛ inch play and the fourth 3/16 inch play, as indicated in Figs. 2 and 3. This is also clearly shown in the four sectional sketches, Figs. 11 to 14. If this is understood it will be clear that under the influence of the spring, K, the top wedge bar, Fig. 11, will be released first and the others in succession as the space in the slots is taken up. Four bars are represented by Fig. 11, and when these are released the spring, K, releases four more represented by Fig. 12 and so on. Since there are eight carriers in all or four sets of two each, it is necessary for the spring, K, to release the wedge bars four at a time until all are free.

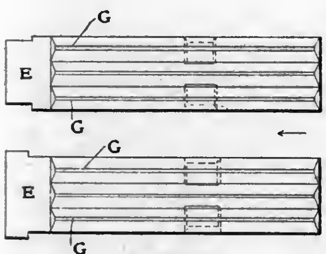


Fig. 10

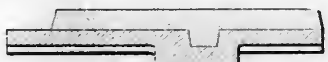


Fig. 11

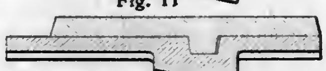


Fig. 12

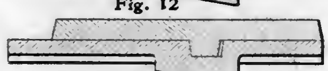


Fig. 13

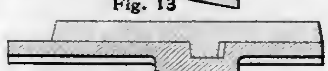


Fig. 14

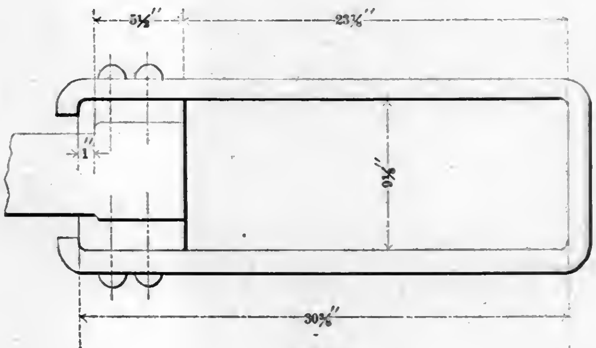


Fig. 15

The operation of buffing is exactly similar to that of pulling, in that the follower plates are moved toward each other, but of course the load comes first upon the outer follower in this case. The application of the spring and friction resistances and the manner of fractional release are the same for pulling and buffing.

A large number of these draft gears are in use and the device has for a long time been past the experimental stage. It is successful under the severest conditions of service as stated in our description of the application to the tender of the very heavy locomotives of the Union R. R. in March. Not the least of its advantages are the effect of the absorption of shocks in collisions and the immunity from break-in-two accidents. Experience shows it to be almost impossible to break a train apart when fitted with this device unless the couplers are defective.

Atlantic Type Passenger Locomotive—French State Railways.

BUILT BY THE BALDWIN LOCOMOTIVE WORKS.

ATLANTIC TYPE PASSENGER LOCOMOTIVE.

French State Railways.

Built by the Baldwin Locomotive Works.

By the courtesy of the Baldwin Locomotive Works the accompanying photograph of one of a lot of 10 Atlantic type locomotives recently built for the French State Railways is shown. These engines are for express passenger service. They are not large or powerful when compared with recent passenger locomotive development in this country, but they are interesting because of the acceptance of the piston valve and the Atlantic type in France. The firebox is narrow and the grate area but 35 square feet. The heating surface of 2,095 square feet seems small to us, but it is rather unusual in French practice. The boiler is long, because of the 15-foot tubes. The firebox is of copper and the working pressure is 213 pounds. The boiler tapers toward the rear. This was done to save weight and to save room in the cab, but its effect is scarcely noticeable in the engraving. Among the other noticeable features are the Baldwin piston valves, driving and trailing wheel brake shoes at the rear of the wheels, and oil cups on the sides of the boiler above each axle, with tubes leading to the journals. The tender has two four-wheel trucks, a water scoop and a running board extending its full length. The leading dimensions of the engines are as follows:

General Dimensions.

Gauge	4 ft. 9⅛ in.
Diameter cylinders	17¼ in.
Stroke	26 in.
Valve	Balanced piston

Boiler.

Diameter	58 in.
Thickness of sheets	11/16 in.
Working pressure	213 lbs.
Fuel	Soft coal

Firebox.

Material	Copper
Length	120 in.
Width	42 in.
Depth	Front, 71¼ in.; back, 67½ in.
Thickness of sheets	Sides, ⅝ in.; back, ⅝ in.; crown, ⅝ in.; tube, ⅝ in. and ⅞ in.

Tubes.

Number	246
Diameter	2 in.
Length	15 ft. 1 in.

Heating Surface.

Firebox	170.43 sq. ft.
Tubes	1,925.44 sq. ft.
Total	2,095.87 sq. ft.
Grate area	35 sq. ft.

Driving Wheels.

Diameter outside	84¼ in.
Diameter of center	78 in.
Journals	8 x 10 in.

Engine Truck Wheels.

Diameter	36 in.
Journals	6 x 10 in.

Trailing Wheels.

Diameter	54¼ in.
Journals	8 x 10 in.

Wheel Base.

Driving	7 ft. 3 in.
Rigid	14 ft. 6 in.
Total engine	26 ft. 8 in.
Total engine and tender	55 ft. 2 in.

Weight.

On drivers	71,905 lbs.
On truck	32,700 lbs.
On trailing wheels	34,450 lbs.
Total engine	139,055 lbs.
Total engine and tender	219,000 lbs.

Tender.

Diameter of wheels	36 in.
Journals	4½ x 8 in.
Tank capacity	3,600 gals.

NEW OFFICE BUILDING OF THE WESTINGHOUSE ELECTRIC & MANUFACTURING CO.

The Westinghouse Electric & Manufacturing Co. has found it necessary to repeatedly add to its facilities for manufacturing, and with the present demand for large generators, even up to 5,000 and even 8,000 h. p., in capacity the plant at East Pittsburgh became so outgrown as to require the recent addition of 11½ acres in floor space. The space formerly occupied by the offices became indispensable to the manufacturing departments. A large building has just been completed for the offices which are now provided for outside of the manufacturing building at East Pittsburgh. It is 250 by 50 feet and 7 stories in height. It is fireproof and pleasing architecturally. Its appointments are noteworthy in completeness and character. Fireproof vaults occupy 1,200 square feet of space on each floor, and they furnish safe storage for plans and valuable records. The employment and store departments occupy the first floor. The rooms for the managing officers and the reception room, on the second floor, are specially convenient and attractive; they are well furnished and are in good taste throughout. The third floor is occupied by the Westinghouse Companies Publishing Department, the accounting offices and those of the auditing, paymaster's, treasuer's, legal and cost departments. The mechanical engineering department has the entire fourth floor, and the fifth is occupied by the electrical engineers. Two handsome dining rooms are located on the sixth floor, and this floor also provides for the telephone exchange for the works. A third dining room here is provided for the lady stenographers. The heating is by direct steam and the lighting and ventilation have been given unusual attention. The temperatures throughout the building are regulated by automatic themostatic valves. The elevators are operated on the electro-hydraulic system from power furnished by two Westinghouse "Type C" motors, operating pumps which force water from the low pressure to the high pressure tank. These are regulated automatically. The offices and all of the departments of the works are connected by a pneumatic tube system with a central exchange station. This comprises 12 sending and receiving tubes, furnishing service to all floors of the office building and connecting to important points in the works. The longest line is 3,500 feet and the circuit is made through it at a speed of about 60 miles per hour. The system operates by a vacuum of about 24 ounces, which is sufficient for handling carriers weighing 8 lbs. The tubes are 2½ inches diameter and of brass. This system is employed for the distribution of mail and the transmission usually performed by messengers. The entire installation has been planned and executed with a view of ultimate economy in the operation of this vast establishment.

EDITORIAL CORRESPONDENCE.

Illinois Central.

Mr. Renshaw is entirely satisfied that the heavy locomotives recently built for this road, one by the Brooks and the other by the Rogers people, are doing what was expected of them, although they have not as yet been tested for coal and water consumption. The purpose of these engines was not, as first reported, to handle trains over Cairo bridge only, but to permit of hauling the same trains over the 95 miles between Carbondale and Fulton, Ky., that are hauled by the lighter engines over the rest of the road between Chicago and New Orleans. This short section contains the heaviest grades and is the only part of the road requiring very heavy locomotives. Engine No. 640 is handling trains of from 1,800 to 2,000 tons over 40-foot grades between Centralia and Cairo, with a steam pressure of 210 pounds. Last October this engine hauled a train of 83 cars, weighing 3,400 tons, from Kankakee to Chicago, 56 miles, at a rate of 12 miles per hour over grades of 26 feet per mile. These engines are used on the road and not, like the Union Railway engines at Pittsburgh, for very short runs. The road service necessitates a large amount of fuel and water, and Mr. Renshaw is considering the design of a tender to carry 9,000 gallons of water and 18 tons of coal. With the present tenders, which were described in connection with these locomotives, Mr. Renshaw has found it necessary to furnish a coal passer to assist the fireman. This additional expense seems likely to be a necessary accompaniment of such heavy engines in regular road service, but the advantage of the heavier trains is believed to render this expense negligible.

Artificial refrigeration is undergoing experiment on this road. The details of the system will be reserved until it has developed further. The apparatus occupies the space formerly taken up by one of the end ice boxes, saving the space of the other box for the freight. About 1,000 linear feet of small copper pipe furnishes the cooling surface, and through this pipe a chemical is evaporated. The chemical requires but 35 pounds per square inch to take the liquid form. It is passed into the coil as a liquid and evaporates, and while doing so absorbs heat after the manner of all systems of this general character. Power is taken by a belt from the axle to compress the refrigerating agent back to the liquid form and to circulate the air in the car. It is stated that the temperature may be kept down to about 5 degrees F. by this system. A good mechanical refrigerating system which is not too complicated appears to have a wide field for fruit and meat transportation. There is no delay for icing cars, and this, on a through run on this road, amounts to seven hours. The cost of the apparatus is to be compared with that of providing ice, and its weight, including that of the water for cooling the refrigerating medium, is less than that of the ice. The cost of the ice is saved, probably entire, because the interest on the investment will be returned in the form of fuel saving on account of the diminution of delays. The idea seems promising.

CONVENTION OF AIR BRAKE MEN.

The Air Brake Association held its seventh annual convention in Jacksonville, Fla., opening April 3. The first subject for discussion was: "Recommended Practice for Successful Handling of Passenger and Long Freight Trains." The committee report contained the following conclusions:

1. The air brake work required for a stop increases much more rapidly than the speed.
2. On a level grade the entire brake retardation is available for stopping.
3. On a descending grade a certain portion of the brake retardation is required to prevent a gain in speed.
4. On a descending grade the work required of each brake to prevent a gain in speed increases with the weight of the load per brake.
5. The brake retardation available for stopping on a grade is that in excess of what is necessary to prevent a gain in speed.
6. The brake retardation possible from a certain shoe pressure decreases as the speed increases.
7. The longer the distance (and consequently time) required for a stop, the further will it be prolonged by brake cylinder leakage.

The committee went carefully over the considerations of safety in letting trains down long steep grades, recommending frequent applications and great care, in entering the grades, to reduce speed to a point of safety. The use of hand brakes to hold trains making long stops on steep grades was recommended in order to guard against the starting of the train on account of leakage. Instructions for handling trains on heavy grades were given at length, and summed up by the committee.

In the discussion a leaning in the direction of a desire for pressures higher than 70 pounds appeared. In ore trains, especially, a higher pressure was needed for loaded cars, and 70 pounds was only enough for empty cars. One speaker favored an increase of 25 per cent. An increase in the size of reservoirs was recommended. The effect of doubling the capacity of the main reservoir was to greatly improve the releasing of the brakes of 50 and 60-car trains, with 40,000 cubic inches capacity, and it was possible to release the brakes at the rear of such trains before the slack would run out. The fact that some roads were using the air brake on 65 cars in one train called out favorable comment, in view of the limitation of the number of air braked cars in trains to 20 on certain roads. The excellent method of handling the air brakes on the Nashville, Chattanooga & St. Louis Railway were noted, and commended, as a result of the attention given to the care and operation of the brakes by the management of the road, and the painstaking records of the parting of trains.

In discussing the piping of cars, the effects of the very crooked train pipes on hopper cars was referred to. Recent cars of this type often had four elbows, and each of these was equivalent to 15 ft. of straight pipe in resisting the action of the brakes.

In a report upon the lubrication of brake apparatus it was shown to be as important to avoid excessive as it was necessary to give sufficient lubrication. The committee on this subject suggested a rule for the use of the air-pump lubricator. A feed of ten drops of Galena valve oil per minute for the first five minutes after starting the pump, and one drop per minute during the remainder of the run was recommended as good practice. The quantity depended, however, upon the condition of the pump.

Next to the handling of long trains, and trains of all kinds on mountain grades, the most important subject was regulation of the travel of brake cylinder pistons. The brake slack adjuster was considered necessary as a measure for overcoming the sliding of wheels. Without automatic slack adjusters even low pressure could not be depended upon to prevent sliding of wheels, but with the McKee slack adjuster one speaker had been able to increase the braking power to 90 per cent. without having a single case of wheels sliding in two months.

A novel electric locomotive crane, capable of lifting and transporting articles of the weight of heavy frogs and steel rails has been designed and built by the J. G. Brill Co., of Philadelphia, and will be illustrated and described in a future issue. The power is taken from a trolley similar to that of a street car, and the motors for hoisting and locomotion are under the car. The idea is a new one, and the advantages suggested by it are many and important. Such a crane would be very valuable in railroad shops and yards because of its convenience and flexibility. Electric power is now available in nearly all plants, and by stringing a system of trolley wires the entire storehouse and storage yards would be served by this crane. The tracks may be extended into the machine shops and the crane used for handling wheels, axles and heavy castings. A large railroad repair shop could probably keep several of them busy and the cost would soon be saved in the reduction of laboring gangs. The J. G. Brill Co. have one in their works and find it most satisfactory.

TRACTIVE POWER OF TWO-CYLINDER COMPOUNDS.

By C. J. Mellin.

Chief Engineer Richmond Locomotive and Machine Works.

The theory of the tractive power of compound locomotives appears to be of more general interest among railroad men than ever before, and, upon requests from a number of people, the writer submits herewith a development of it.

The conditions in starting a compound locomotive differ somewhat from those of the normal working of the engine, and, consequently, the tractive power is based on the latter condition, but it may be of interest to follow up what takes place in the cylinder from the moment the throttle is opened until the engine assumes its normal state of compound working.

On opening the throttle the steam enters the high-pressure cylinder direct, as in the case of a simple engine, and to the low-pressure cylinder, also from the throttle, through a passage generally governed by an automatic stop and reducing valve, so proportioned that the pressure (p) admitted to the low-pressure cylinder steam chest bears the same relation to the pressure (P) in the high-pressure steam chest as the high-pressure piston area (a) bears to the low-pressure piston area (A) or $p:P = a:A$, which give the same power on both sides of a two-cylinder compound engine.

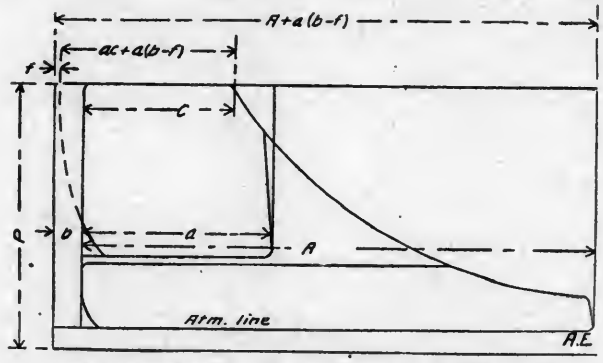
The receiver in the meantime being closed from the low-pressure cylinder by the intercepting valve, there is only atmospheric resistance to both pistons during the first stroke. After the second or third exhaust from the high-pressure cylinder this steam has accumulated in the receiver to the required initial pressure in the low-pressure cylinder, and the engine, if provided with an automatic intercepting valve, goes over into compound working without any manipulation on the part of the engineman; that is, the pressure in the receiver opens the intercepting valve, which valve, by its motion, closes the stop and reducing valve, whereby the admittance of live steam to the low-pressure cylinder is shut off and the high-pressure exhaust steam is admitted to the low-pressure cylinder. The engine is then working compound, and it is in this condition tnat its tractive power is to be calculated.

The resultant work of a compound engine is based on the low-pressure cylinder, and the general average pressure of the steam that is let into and expanded throughout the engine. The high-pressure cylinder enters the formula as a measurement of the initial steam volume, and it subdivides the work of the engine with the low-pressure cylinder, the former working in the upper stage and the latter in the lower stage of the range of pressure from the initial to the terminal. This subdivision also divides the range of temperatures in the same manner as that of the pressure, making the variation only one-half of its entire range in each cylinder, and makes it possible to utilize a maximum amount of the expanding power of the steam with the least variation of temperature or loss by condensation in the cylinders.

The initial volume of the steam used during one stroke of the engine is the volume of the high-pressure cylinder up to the point of cut-off plus the volume of the cylinder clearance. There has, however, been compression from a previous stroke that has made up part of the clearance, which will be subtracted from this volume to get the amount of steam supplied by the boiler to fill this space. Then we get the initial volume from which the work of the engine is obtained.

We now designate this volume, with reference to the high-pressure cylinder, calling the high-pressure cylinder volume = a, cut-off = c, the cylinder clearance = b and the compression = f, when the volume used is = $ac + a(b-f)$, a being the unit and c, b and f expressed in percentage of a. The final volume is that displaced by the low-pressure piston up to the point of release plus its cylinder clearance less the compression.

In designating this in same manner as that of the high-



Tractive Power of Two-Cylinder Compounds.

pressure cylinder by using capitals for corresponding quantities, calling the volume displaced by the piston to the point of release, E, we get the final volume $A\,E + A(B-F)$, or calling the space from the points of release to the end of the stroke G, we can signify the final volume by $A-(G\,A)+A(B-F)$.

Again, by substituting the clearance, less the compression, $A(B-F)$, in the low-pressure cylinder with the volume from the point of exhaust to the end of the stroke, G A, and the clearance, less compression, of the high-pressure cylinder $a(b-f)$, which aggregate about the same amount, we eliminate several terms from the formula that in most cases will have to be assumed anyway, and we get a simpler expression of the whole problem, which then will be $A + a(b-f)$, and the number of expansions

$$N = \frac{A + a(b-f)}{ac + a(b-f)} \qquad (1)$$

as illustrated in the sketch.

This being the foundation of the problem, we can proceed on known methods for its solution, where it will be noticed that the areas of the cylinders are substituted for volumes in the calculation, which may be done when the stroke of the pistons are the same.

Since the number of expansions are known, we get the theoretical average pressure

$$P_1 = \frac{P + \text{hyp. log } N}{N} - 15 \qquad (2)$$

where P is the absolute initial pressure or boiler pressure plus the atmospheric pressure. The hyperbolic log, N, is found in any hand-book that treats on the subject of steam.

P_1 = the theoretical average pressure. The actual average pressure, P_2, is about 80 per cent. of P_1, due to wire drawing of the steam in ports and passages, and we have the tractive power

$$T = \frac{d_1^2\, P_2\, S}{2\,D} \qquad (3)$$

in which d_1 = diameter of the low-pressure cylinder, S = stroke of piston, and D = diameter of drivers.

This formula is derived from the fundamental formula

$$T = \frac{0.7854\, d^2\, P_2\, 2\, S}{3.1416\, D}$$

which, after cancelling gives the above.

Now let us apply these formulas to an engine with 21-inch and 33-inch by 26-inch cylinders, 56 inches in diameter of drivers and 200 pounds boiler pressure (P = 215 pounds.) C = 85 per cent.; b = 8 per cent., and f = 2 per cent. of a. A being 850 square inches, and a being 340 square inches, we have from formula (1):

$$N = \frac{A + a\,(b - f)}{a\,c + a\,(b - f)} = \frac{850 + 340\ (0.08 - 0.02)}{(340 \times 0.85) + 340\ (0.08 - 0.02)} =$$

2.81 expansions.

The hyperbolic logarithm for 2.81 = 1.0332, hence we get from formula (2):

$$P_1 = \frac{P\,(1 + \text{hyp. log. } N)}{N} - 15 = \frac{215\ (1 \div 1.0332)}{2.81} - 15 = 140.5$$

pounds, and the actual average pressure $P_2 = 140.5 \times 0.80 = 112.4$ pounds.

By inserting the value of P_2 in the third formula, we get

$$T = \frac{d^2\, P_2\, S}{2\,d} = \frac{33 \times 33 \times 112.4 \times 26}{2 \times 56} = 28{,}411 \text{ lbs.,}$$

tractive power.

CORRESPONDENCE.

PROPORTIONS, HEATING SURFACE, TUBE AREA, AIR OPENINGS AND STACK AREA.

To the Editor:

Can you or any of the readers of your valuable paper tell me whether there is any accepted rule for the proportion in a locomotive between the area of the openings in the grate, the area of the openings of the tubes and the smallest area of the stack?

I do not remember having ever read anything on this subject and I shall be much indebted for information thereon.

Our standard freight locomotives designed and built in our shops have 960 sq. in. openings in the grate, 553 sq. in. openings of 230 tubes 1¾ inches inside diameter, and 189 sq. in. smallest area of stock. Taking the openings in the grate as 100, the openings of the tubes would be 58, and the stack 20.

J. G. BEAUMONT,
Superintendent of Machinery,
Arequipa, Peru, March 9, 1900. Southern Railway of Peru.

CHANGING THE CENTER OF GRAVITY OF A LOCOMOTIVE.

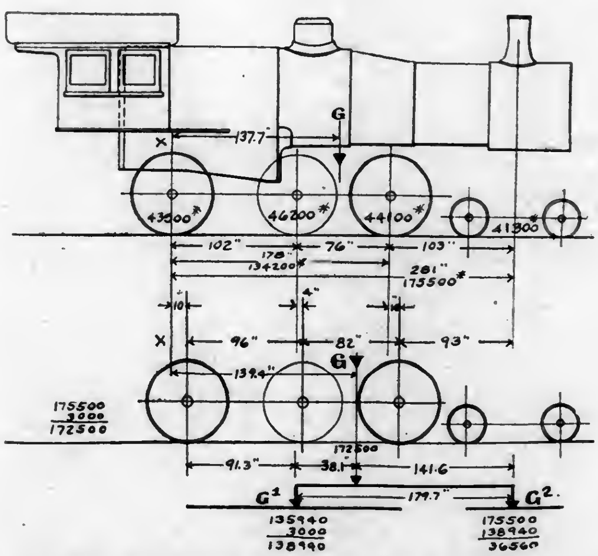
To the Editor:

On reading Mr. Cole's excellent articles on the center of gravity of locomotives in the last two numbers of your valuable journal, it occurred to me that a calculation recently made by the writer may be of interest to your readers.

It was proposed to modify the design of a heavy ten-wheel engine to increase the weight on the drivers and to reduce the weight on the truck. The locations of the drivers were to be moved forward as much as the necessary clearance of valve motion and other parts would permit. These clearances were found to allow the front and back drivers to be moved ahead 10 inches and the main drivers 4 inches. The problem was to find the new center of gravity and the new distribution of weight. The sketch shows the wheel-base and weight distribution of the original engine. To find its center of gravity, taking the moments in inch-pounds around the center line of the back driver, X—X, we have:

Weight.	Moment.
43,900 × 0 in. =	
46,200 × 102 in. =	4,712,400
44,100 × 178 in. =	7,849,800
41,300 × 281 in. =	11,605,300
Total..175,500	Total..24,167,500

and dividing this total moment by the total weight we have



Moving the Center of Gravity of a Locomotive.

137.7 inches, which is the distance from the line X—X to the center of gravity of the engine. The new center of gravity is found by taking the weights of the parts moved ahead and multiplying each by the distance moved. The sum of these products gives us the total moment or leverage to be added to that of the original design, and since we have not added anything to the total weight, dividing the new total moment of 24,467,740 inch-pounds by 175,500 pounds as before, we have 139.4 inches for the new center of gravity measured forward from the line X—X. As the weights involved may be of interest, I give this otherwise routine part of the calculation complete.

Parts Moved.	Lbs. Weight.	Inches Moved.	Inch-lbs. Moment.
Front driving wheel centers	4,000	10	40,000
Front driving wheel tires	2,380	10	23,800
Front driving boxes	1,000	10	10,000
Front driving axles	1,100	10	11,000
Front driving springs	480	10	4,800
Front driving spring hangers	250	10	2,500
Front driving spring seats and hooks	543	10	5,430
Front driving brake work	400	10	4,000
Front driving frame pedestal	500	10	5,000
Front crank pins and rods on front pin	884	10	8,840
Front equalizers	250	3	750
Links and front half of eccentric rods	455	6	2,730
Rock shafts and boxes	530	6	3,180
Reverse shaft, boxes and spring	332	6	1,992
Main driving wheel centers	5,000	4	20,000
Main driving wheel tires	2,500	4	4,000
Main driving boxes	1,000	4	4,000
Main driving axle	1,200	4	4,800
Main driving springs	480	4	1,920
Main driving spring hangers	250	4	1,000
Main driving spring seats and hooks	543	4	2,172
Main driving brake work	400	4	1,600
Main driving frame, pedestals, etc	500	4	2,000
Main crank pins and rods on main pins	2,036	4	8,144
Main equalizers	464	3	1,392
Eccentrics (sheaves)	520	4	2,080
Eccentric straps	600	4	2,400
Eccentric rods (back half)	70	4	280
Back driving wheel centers	3,950	10	39,500
Back driving wheel tires	2,380	10	23,800
Back driving boxes	1,000	10	10,000
Back driving axles	1,100	10	11,000
Back driving springs	480	10	4,800
Back driving spring hangers	250	10	2,500
Back driving spring hooks and seats	543	10	5,430
Back driving brake work	400	10	4,000
Back driving frame, pedestals, etc	500	10	5,000
Back crank pins and rods on back pins	840	10	8,400
Total moment added			300,240
Total moment of original engine			24,167,500
Total moment of new engine, lbs			24,467,740

divided by the total weight, 175,500 = new center of G. = 139.4 in.

As the three pairs of drivers are equalized together each wheel would be loaded equally above the springs; the only variation being in the dead loads or weight carried between the springs and the track. The dead load on the front and back drivers being approximately equal, we deduct the excess load (in this case about 3,000 pounds) from the main drivers. The center of gravity of the drivers is then found by adding the distances of each pair from the center line of the back one and dividing the sum by the number of pairs. This is following the same rule as used above, but if the weights are equal we can assume the most convenient figure, which is 1. Now we can consider the total weight (less the 3,000 pounds deducted) supported on two points; one G^2, the center of the truck, and the other G^1, the center of gravity of the three pairs of drivers. Having the location of the two points of support G^1 and G^2, and the point of the total load G, we can find the weight on either point, as G^1, by the principle of levers, thus:

$$\frac{172{,}500 \times 141.6}{179.7} = 135{,}940$$ pounds, which, after adding the 3,000 pounds previously deducted, equals 138,940 pounds, or the weight on drivers. By subtraction from the total we obtain the weight on the truck, 36,560 pounds.

The weight below the springs is not always readily obtained, and for preliminary or rough calculations I have found the table given below to be very useful. It gives the per cent. of weight on drivers carried below the springs.

	Per cent.
4 Eight-wheel engines averaged	26.1
3 Ten-wheel engines averaged	23.4
2 Four-wheel engines averaged	17.8
2 Six-wheel engines averaged	17.8
1 Twelve-wheel engine	26.5
3 Mogul engines averaged	20.3
3 Consolidation engines averaged	19.8

Hartford, Conn., April 21, 1900. F. K. CASWELL.

DEEMS' TEMPERATURE REGULATOR FOR LOCOMOTIVE TENDER FEED-WATER HEATERS.

The application of the exhaust steam from the air brake pump to heat the feed water in the tenders of locomotives is now quite common. It would be more so if it were not for the danger of getting the water too hot for the injectors. As a result of this danger enginemen are afraid to allow the water to get as hot as it ought to be for fear that the injectors will give them trouble. Mr. J. F. Deems, Assistant Superintendent of Motive Power of the C., B. & Q. R. R., has patented an automatic device to regulate the temperature of the water so that the benefits of heating may be had without this difficulty.

Mr. Deems has kindly furnished these drawings. He states that the temperature is held within a range of 5 degrees. The device has three principal parts; (1) a thermostat tube, G, placed in an inclined position in the water of the tank; (2) a valve controlled by the thermostat which admits air pressure from the air brake supply, to (3) a two-way valve, C, at the air pump by which the air pump exhaust is turned either to the stack or into the heater coil in the water tank. The thermostat or "expansion chamber" is a piece of 2 in. gas pipe containing approximately 450 cubic inches of water. Its upper end opens under a flexible diaphragm in the lower part of the valve shown in Fig. 2.

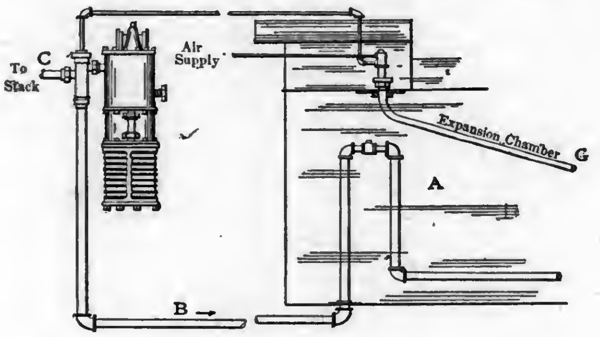


Fig. 1

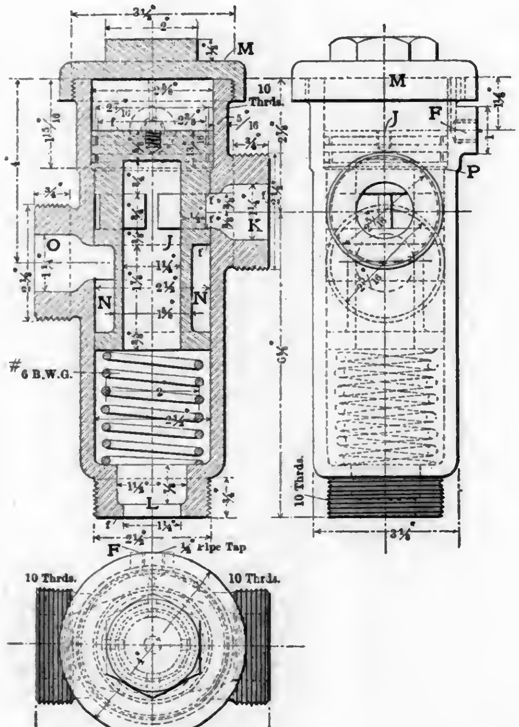


Fig. 3

The regulating valve, Fig. 2, has two air pipe connections in its upper part. The upper pipe, B, admits air from the main reservoir to the double regulating valve. This regulating valve when in its middle position permits air to pass from the air supply into the lower pipe, D, and to the space above the piston of the exhaust steam valve, Fig. 3, pressing the steam valve downward against the spring and opening the passage for the air pump exhaust to pass into the tender tank. The steam passes through the valve and its passage to the stack is cut off. In Fig. 3 the exhaust enters at K and passes out at O for the stack, and at L for the tender. A cap, M, gives access to the interior.

If the device is adjusted to turn the exhaust toward the stack when a temperature of, say, 120 deg. has been reached, at that point the water in the expansion pipe raises the diaphragm of Fig. 2 and raises the double valve into its upper position. This cuts off the air from the exhaust steam valve and the air contained in the pipe leading between the two valves leaks out. When the pressure runs down the spring under the exhaust steam valve, Fig. 3, moves the valve upward, closes the passage to the heater and turns the exhaust to the stack.

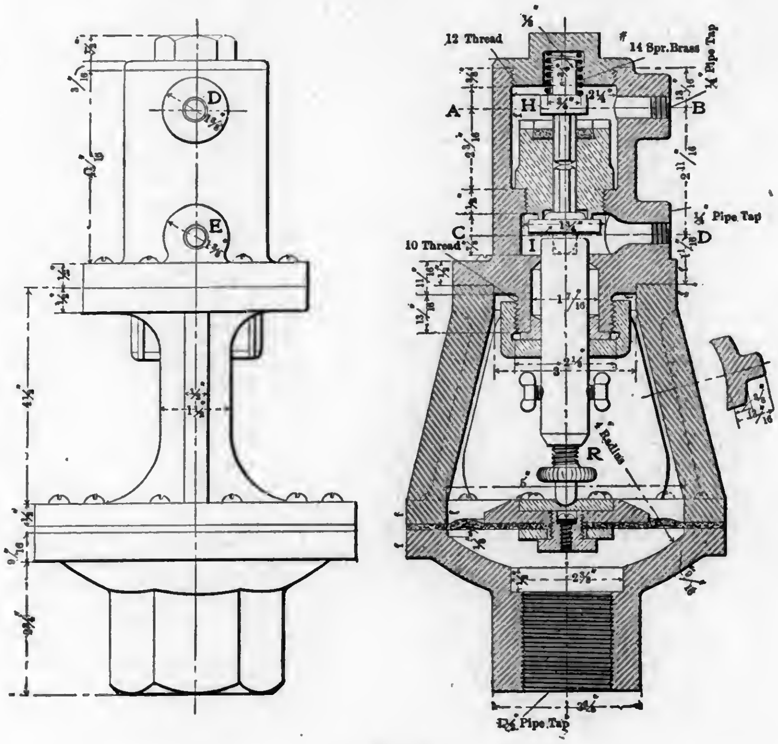


Fig. 2

The upper seat and valve H of the double valve of Fig. 2 is provided as an emergency feature to be called into action only in case the water leaks out of the thermostat pipe. The amount of air used is infinitesminal. The adjustment of the regulation is made by the screw, R, above the diaphragm of Fig. 2.

The device is inexpensive to construct and it costs practically nothing to operate. It seems likely to remove the only difficulty in heating the feed water in the locomotive tender. Owing to the fact that the temperatures of the air and the water in the tank are practically the same, the expansion pipe appears to act equally well with large or small amounts of water.

The Institution of Mechanical Engineers and the Institution of Civil Engineers of Great Britain desire to combine with their next meetings a reception of the members of the American Society of Mechanical Engineers, who will visit England shortly. The Institution of Mechanical Engineers have arranged to hold their next meeting in London in the last week in June next, and the Grand Hall of the Hotel Cecil has been engaged for their annual dinner on June 27th.

A NEW PLAN CONCERNING THE PURDUE LOCOMOTIVE TESTING PLANT.

The locomotive laboratory of Purdue University was established for the purpose of instructing students, and during the eight years of its existence it has never failed to serve this purpose well. The opportunity which the plant offers for work of research has, however, never been lost from view, and in recent years small sums of money have from time to time been made available for such work. This has served to develop some facts for several committees of the Master Mechanics' Association and to advance several important lines of work projected by Prof. W. F. M. Goss, whose name is so closely associated with this admirable institution. Various commercial tests for which money has been received have helped to swell the volume of the business done. Thus far, however, the business has not been sufficient to completely occupy the plant. The instructional work, the research which can be paid for by the Purdue Trustees, and the commercial work, all combined, have not, in the past, been sufficient to warrant the maintenance of a permanent force of attendants about the plant, with the result that the work which has been accomplished has been done at a disadvantage and real progress has been slow. Moreover, the limitations arising from this course have prevented the acceptance of many opportunities for commercial work which, under more favorable conditions, could have been accomplished with profit.

It is the desire of the Trustees of Purdue that the locomotive testing laboratory shall be made to serve as large a sphere of usefulness as practicable. While unable themselves to provide funds for its continuous operation, they are ready to extend every encouragement to others who may assist to such an end. To sustain a permanent organization at the plant, and to provide supplies of fuel, oil, etc., needed for its continuance will require the expenditure of from $6,000 to $8,000 a year. It would seem not unlikely that the business demands of the whole country would equal this amount, at least for a single year. It is proposed, therefore, to ask those who are likely to be interested in the subject to subscribe for work to be done at times which may be agreeable between September 1, 1900, and September 1, 1901. Thus, Messrs. X. & Co. may signify their willingness to invest in the laboratory to the extent of $1,000; Messrs. Y. & Co. to the extent of $2,000, while individuals may come in for amounts as low as $100. In the event that a sufficient amount is subscribed to warrant an organization on the basis indicated, they may at any time within the 12 months indicated arrange to have work done and reported upon by the regular laboratory authorities with the expectation of paying a fair amount for each test or each investigation, which amount will be credited against the amount they subscribed.

The purpose of the charge and the basis upon which it will be fixed will be such as to cover labor and material accounts only. Nothing will be charged for the use of the plant, or for deterioration, or for repairs except such as may result from the progress of the individual work in hand. The laboratory authorities will hold themselves in readiness to quote in advance fixed prices for all work that may be proposed. An estimate of what may be accomplished for a given amount may be made from the following statement. To run the plant the daily labor costs will be about as follows:

One fireman	$2.50	
One coal passer	1.50	
One oiler and attendant	2.50	
One man for mounting mechanism	1.50	
Two permanent observers at $2.50	5.00	
One foreman	3.00	
Total		16.00
Offiffice expense in summarizing data and formulating report, chargeable to one day's running	6.50	
Allowance to cover loss for periods of enforced idleness	2.00	
Total expense per day (engine not running)		$24.00

This expense would be expected to continue whether the engine was actually under steam or not. The observers and foreman at such times assisting in the office work, while the less expensive labor would be making needed preparations for the next run. To the above estimate covering fixed charges, there is to be added, for days when the engine would be under steam, an additional item of $15 to cover cost of fuel, oil and other supplies, making the total cost per day (engine running) $39.

It will be seen on the basis of the above estimate that one desiring a test of a valve, or a valve mechanism, or of an exhaust nozzle, or any small thing which could be determined in a single day's running, could secure all the information desired for something less than $100. This statement, while merely an indication of the basis upon which it is proposed to make charges for work done, is offered for the guidance of proposed subscribers.

The character of the work which may be undertaken may be anything for which the plant is adapted. It may include a determination of the value of different fuels used under conditions of locomotive service; tests of improvements in the parts of locomotives, as, for example, valve gears and other portions of the mechanism, stacks, draft appliances, lubricators, etc., or it may include tests of complete locomotives. Thus, any locomotive within the capacity of the plant could be received at the laboratory, mounted, subjected to a series of careful tests, and delivered from the laboratory ready for shipment.

It is recognized that the fact that proposed patrons are asked to signify their intention some months before work can be undertaken, has a distinct disadvantage in the working out of the proposed scheme, but inasmuch as the University cannot venture money in a business operation, the condition leading to the objection is a necessary one, though in part, at least, compensated for by the tender on the part of the University of the free use of an expensive plant and the consequent low price at which it is proposed to do work.

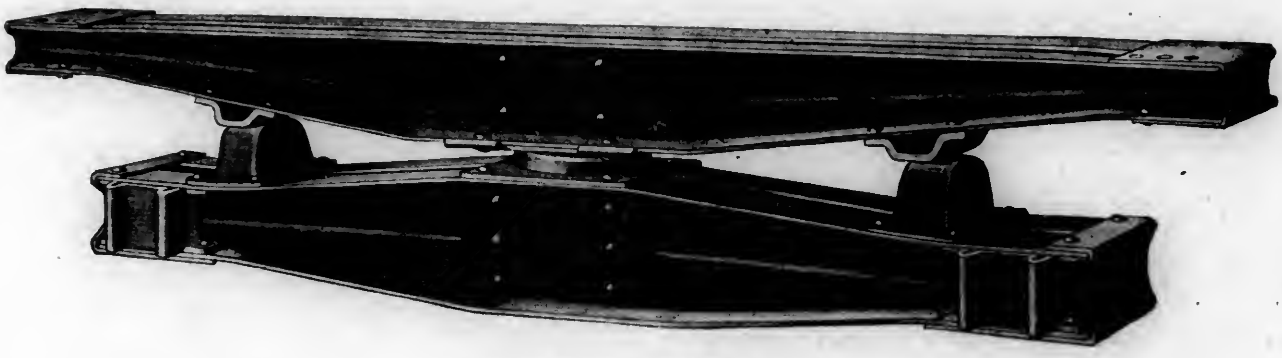
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

Semi-Annual Meeting.

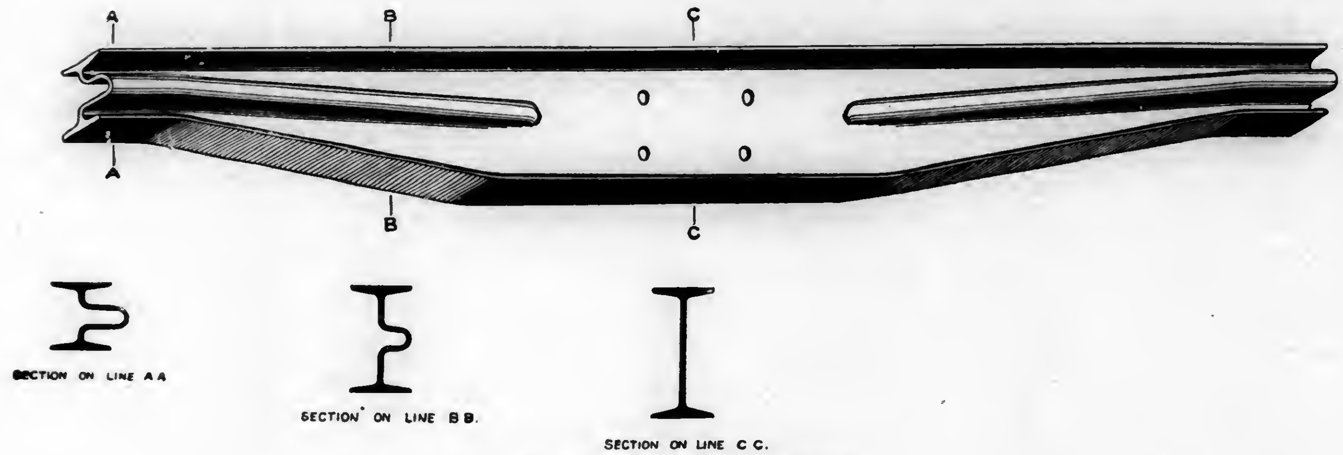
The forty-first meeting of the American Society of Mechanical Engineers will be held in the Grand Hotel, Cincinnati, May 15 to 18. The address of welcome will be delivered by the Hon. Gustav Tafel, Mayor of Cincinnati, at 8.30 p. m., May 15, and the response will be by Mr. Charles H. Morgan, President of the society. The program of subjects is as follows:

Rockwood, Geo. I., "On the Value of a Horse Power"; Yaryan, H. T., "Hot Water Heating from a Central Station"; Aldrich, W. S., "Systems of Efficiency of Electric Transmission in Factories and Mills"; Guest, J. J., "Design of Speed Cones"; Thurston, Robt. H., "Multiple Cylinder Engines"; Magruder, Wm. T., "The Gas Engine Hot-Tube as an Ignition Timing Device"; Goldsmith, N. O., "Water Softening Plant of the Lorain Steel Co."; Higgins, M. P., "Education of Machinists, Foremen and Mechanical Engineers"; Herschmann, Arthur, "The Automobile Wagon for Heavy Duty"; Cooley, M. E., "A Test of a Fifteen Million High Duty Pumping Engine at Grand Rapids, Mich."; Goss, W. F. M., "Tests of the Snow Pumping Engine at the Riverside Station of the Indianapolis Water Company"; Ball, B. C., "Cylinder Proportions for Compound and Triple Expansion Engines." Topical discussions: "What Does It Cost to Run Trains at High Speed?" "Protection of Pen-stocks from Corrosion."

The shops of the Evansville & Terre Haute Railroad at Evansville, Ind., are being greatly improved under the administration of Mr. A. C. Hone, the Superintendent of Motive Power and Rolling Stock. Mr. Hone is a young man and a technical school graduate. He has put new life into the motive power department and has made important improvements. The buildings have been painted, new stationary engines and boilers put in, and the entire equipment has been brought up to a state of modernism in condition and appearance. Five or six engines are in the shops at all times for overhauling, as well as about the same number of coaches, baggage and other cars.



The Bettendorf I-Beam Bolsters.



The Bettendorf I-Beam Bolsters.

THE BETTENDORF I-BEAM BOLSTER.

New Method of Manufacture.

These bolsters have been in use for several years and their record is good. The designer had chiefly in mind the advantage of the I-beam section in the distribution of metal in the bolsters in order to secure the maximum of strength with a minimum of weight, together with the advisability of using the smallest number of parts and the selection of material which would permit of making repairs without great expense or difficulty. In the structure the importance of sufficient stiffness to keep the side bearings clear of each other under the loads and the wear and tear of service was considered of first importance, because of the well-known troubles and wastefulness resulting from bolsters being "down on their side bearings."

These engravings show a pair of bolsters complete and a view of one of the I-beams of a body bolster illustrating the new method of manufacture. The I-beams are of open hearth steel and the former practice of cutting out a portion of the web at each end and dovetailing the edges together has been abandoned as unnecessary. The present practice is to press folds into the web, deep at the outer ends and running out into the flat web near the center, and to do this in a powerful hydraulic press without heating the I-beam. The sectional views show the form of these folds and the complete view shows their neat appearance in the finished bolster. An incidental advantage of this process is the severe physical test which the material undergoes in this cold pressing process. Defective or poor qualities of steel will at once be revealed before the construction is completed.

A variety of designs have been brought out for adapting these bolsters to cars of various kinds, for example, those with low side sills, cars with the American Continuous Draft Gear and those with draft timber passing through the bolsters. These bolsters are also easily adapted to any form of truck construction. A very attractive design has been made for body and truck bolsters for 80,000-lb. capacity cars. In these large capacity body bolsters a plate is carried across the top and a short distance around the ends. In the truck bolsters the plate is carried across the lower face and around the ends. This construction provides increased capacity and adds to the resistance to longitudinal, lateral and vertical shocks.

The Cloud Steel Truck Co., manufacturers of the Bettendorf bolsters, also make the Cloud pedestal and diamond frame trucks. The bolsters are now in use on more than 40 railroads. They are spoken of as "examples of good engineering in car construction."

The following railroad officers have received appointment to the Paris Exposition: Mr. A. E. Mitchell, Superintendent of Motive Power of the Erie; Mr. Wm. Renshaw, Superintendent of Motive Power of the Illinois Central; and Mr. W. T. Reed, Superintendent of Motive Power and Machinery of the Seaboard Air Line, have recently accepted appointments as American jurors in Class 32, Group 6, Railway Appliances. Dr. C. B. Dudley, Chemist of the Pennsylvania Railroad, has been appointed delegate to the Congress on Chemistry. Mr. J. F. Wallace, of the Illinois Central, and President of the American Society of Civil Engineers, has been appointed delegate to the Congress on Tests of Materials in June. Mr. L. F. Loree, General Manager of the Pennsylvania Lines West of Pittsburg, has accepted the appointment as delegate to the Railway Congress in September. Mr. J. J. Ramsey, Vice-President and General Manager of the Wabash, has been appointed delegate representing the United States Government at the Congress, and also delegate to represent the American Railway Association.

THE "K. A. K." UNDERGROUND ELECTRIC CONDUIT APPLIED TO CABLE RAILWAYS.

We have received from Mr. O. S. Kelly, of Springfield, Ohio, information concerning the "K. A. K." system as applied to cable railway conduits, also drawings from which the accompanying engravings were made.

A glance at the section of the conduit shows how the electric feeders, insulators and conductors are arranged, to avoid interference with the regular operation of the cable system. In Figs. 1 and 3 the important details of the system are shown. The rails are supported on channel iron ties, which are secured to the yoke, which is of cast iron. The steel pieces, C, are placed directly upon the top of the yoke with one side turned at right angles to form the drip into the conduit. The insulators, D, support malleable pieces, E, on which lips are provided to close around the conduit feeder tubing, G, which is of iron pipe lined with treated wood shown in section at O. The feeder cables, H, pass through these conduits. The tubes are air tight to avoid difficulties with atmospheric and other moisture.

The conductor rails, I, are bolted to the malleable castings, E, as shown in Fig. 3. The conductors are bonded at the ends by heavy flexible copper strips. Provision is made for contraction and expansion in the joints, and also for slight movements of the insulators. The trolley contacts are made by the two springs, K, K, of flat steel or spring brass. They carry cast iron shoes, J, on their lower ends for making contact with the conductor rails and as they are simple and inexpensive, renewals may be cheaply made. The springs, K, are carried in opposite directions at their lower ends; they pass through and are supported in insulating material shown at L, in Fig. 3, which is protected by the steel covering, M,

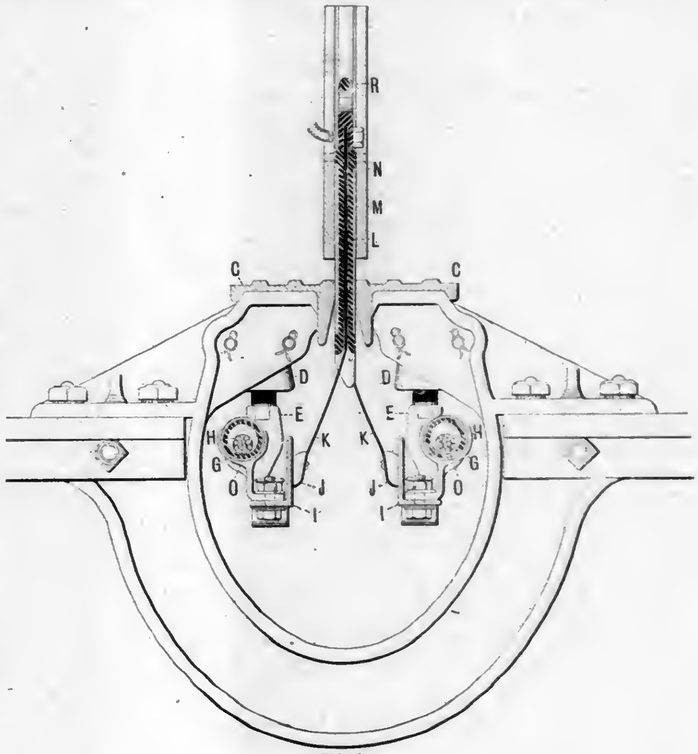


FIG. 3

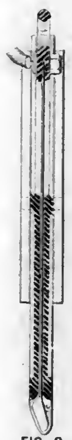


FIG. 2

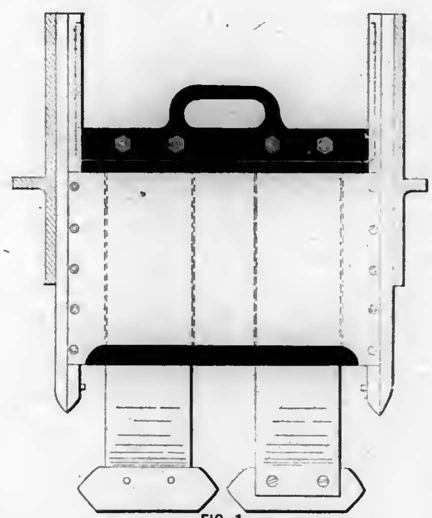


FIG. 1

this being fitted loosely in the base, N, which is permanently secured to the car truck. The springs, K, are fastened at the top by means of the insulating fiber strips, R, and pass loosely through the insulations, L, of the casing, M. The connection to the motors are made by means of the binding posts shown in Fig. 1.

The trolley is raised from the slot by means of the handle on the top of the insulating strip of Fig. 1. This raises the springs, K, and draws the shoes away from the conductor rails and brings them together at the bottom of the casing as seen in Fig. 2. The casing, M, and the shoes are then drawn from the slot. In this system manholes are provided from 300 to 500 feet apart. In these the fuse connections are placed and provisions are made for draining the slot into the sewer. The fuse connections are made with heavy copper wire on insulated screw handles which may be readily detached or replaced without danger. The conductor rails end at the manholes and at these points they are connected to the feeders through the fuses. This construction renders it easy to locate defective insulation, and also prevents disabling the whole line or large part of the line because a grounding of one of the conductors disables one section only. With the return feeder system electrolysis and its serious consequences are entirely prevented. It is obvious that this system may be used in connection with overhead trolleys, the overhead and underground trolleys being connected with the same controlling devices.

THE PROTECTION OF STRUCTURAL METALS FROM CORROSION.

Prof. A. H. Sabin of New York recently delivered an address before the Engineers' Club of Philadelphia upon "The General Chemical Aspects of the Corrosion of Structural Metals, and the Principles Involved in their Protection," and illustrated his remarks by the exhibition of 235 steel and aluminum plates which were exposed for about two years to the action of fresh and salt water. There were originally prepared about 300 plates, each 12 inches wide by 18 inches long, and thick enough not to buckle, and these were divided into three sets, one being placed in the fresh water in Lake Cochituate, near Boston; another in the sea water at the New York Navy Yard, and the third in the sea water at the Norfolk Navy Yard. The plates, after being made perfectly clean under a wire brush, were coated with oil paints, varnishes or enamel paints, with a variety of pigments, so that a great number of different coatings were tested. The results seemed to show in general that in pigment paints the character of the pigment makes little difference in the permanency of the coating. Oil paint seemed to wear much worse than varnish paints, while of the latter, those containing a larger proportion of oil are the best. Baking is not generally beneficial, except in the case of enamels. Fresh water, of course, proved to be much less severe than salt water upon the coatings. Prof. Sabin also briefly described the commercial process of making paints and varnishes.

A SAFE THIRD RAIL ELECTRIC SYSTEM.

The Metropolitan Electric Third Rail & Traction Co., of Boston, Mr. George W. Hills, manager, appreciating the tendency toward the use of a third rail for conducting power to moving trains, has developed a system for rendering the conducting rail harmless to those who may accidentally come into contact with it. The electric elevated roads in Chicago, the Brooklyn Bridge and the electric installation on the New York, New Haven & Hartford R. R. all use the third rail system, and it will be used also in the application of electric traction upon the Manhattan R. R. of New York and on the new elevated lines in Boston. This is a satisfactory indication that the third rail is to be used for the heavier electric railway work, and this led to the study of methods for rendering the rail safe by Mr. George F. Gale, the inventor of the system developed by the company referred to.

The third rail is divided up into short sections insulated from each other, and these are brought into electrical contact and made "live" rails by connecting switches, operated automatically by the presence of the train in the sections in such a way as to put current from the feeders into the conducting rail only for that part of the rail actually in use by the train. The switches open again immediately after the passage of the train, leaving the rail "dead" behind the cars. In this way there is no danger of injury to persons who may touch the rail. Mr. Hills' address is 70 Milk St., Boston, Mass., and further information may be had from him.

PERSONALS.

Mr. R. H. Soule will open an office in New York May 1, as Consulting Mechanical Engineer.

Mr. John M. Egan, Vice-President of the Central of Georgia, has been elected President, to succeed the late H. M. Comer.

Mr. F. A. Cruger has been appointed Purchasing Agent for the Northern Steamship Company, with headquarters at Buffalo.

Mr. Chas. J. Canfield has been elected President, General Manager and Purchasing Agent of the Manistee & Grand Rapids, vice John Canfield, deceased.

J. E. Gould, General Foreman of the Columbia Shops of the Ohio Central, has been appointed Master Mechanic of the Cincinnati Southern at Chattanooga.

Mr. David Brown has been reappointed to his old position as Master Mechanic of the Delaware, Lackawanna & Western, at Scranton, Pa., which he resigned last December.

Mr. William White, Master Mechanic of the Illinois Central at Memphis, Tenn., has accepted an appointment to a like position on the Lake Erie & Western to succeed the late P. Reilly.

Mr. Charles Steele of New York, a member of the firm of J. P. Morgan & Company, has been elected by the Directors of the Lehigh Valley and also by the Directors of Erie to fill the place of the late C. H. Coster.

Mr. W. B. Gaskins has been appointed Superintendent of Motive Power and Machinery of the Pecos Valley & Northeastern, with headquarters at Roswell, N. M., in place of Mr. C. M. Stansburg, who has resigned.

Mr. Arthur Dufty, who has been connected with the Motive Power Department of the Central Railroad of New Jersey for some months past, has been promoted to the position of Foreman of Machine Shops at Elizabethport, N. J.

Mr. Colin M. Ingersoll, Jr., heretofore Assistant to the President of the New York, New Haven & Hartford, has been appointed Chief Engineer of that road, vice Mr. F. S. Curtis, recently elected Fourth Vice-President of the company.

Mr. George A. Barden has been appointed Eastern agent of the Standard Pneumatic Tool Co., with offices at 619 Washington Life Building, 141 Broadway, New York. He was formerly Superintendent of the works of the company.

Mr. Geo. M. Brown, Chief Engineer of the Saginaw district of the Pere Marquette, and who was Chief Engineer of the Flint & Pere Marquette for 30 years, has tendered his resignation to devote his entire time to lumbering interests.

Mr. E. P. Bryan, Vice-President and General Manager of the Terminal Railroad Association of St. Louis, has resigned to accept the position of General Manager of the New York Rapid Transit Subway Company, which is to build the underground railroad in New York.

Mr. Joseph Lythgoe, Superintendent and General Manager of the Rhode Island Locomotive Works of the International Power Company, and Mr. John Howarth, Assistant Superintendent of the same company, have resigned. Mr. John R. McKay will succeed Mr. Howarth.

Mr. George H. Kimball, who was formerly Superintendent and Chief Engineer of the Columbus, Sandusky & Hocking, has been appointed Chief Engineer of the Pere Marquette, succeeding George M. Brown, resigned. Mr. Kimball's headquarters will be at Grand Rapids, Mich.

Mr. J. O. Pattee, who left the position of Superintendent of Motive Power of the Great Northern January 1, 1900, has been appointed Superintendent of Locomotive and Car Department of the Missouri Pacific and St. Louis, Iron Mountain & Southern system, vice Mr. Frank Rearden, resigned to engage in other business.

Mr. Frank Rearden, who has been Superintendent of the Locomotive and Car Department of the Missouri Pacific since November, 1890, has resigned that position. Previous to December, 1888, he was Master Mechanic of the Missouri, Kansas & Texas, at Denison, Tex., and was then Master Mechanic of the St. Louis, Iron Mountain & Southern at Little Rock until he received the appointment of Superintendent of Locomotive and Car Department of the Missouri Pacific.

Mr. J. F. Deems, Master Mechanic of the Chicago, Burlington & Quincy, at West Burlington, Iowa, has received just recognition for his services to the company by a promotion to the position of Assistant Superintendent of Motive Power of that road. Mr. Deems began his railroad career as apprentice in the shops of the Baltimore & Ohio. He left that road in 1889 to enter the service of the Chicago, Burlington & Quincy. He will continue to make his headquarters at West Burlington, Iowa.

Mr. Dwight C. Morgan has been appointed Engineer Maintenance of Way of the Chicago & Alton, with headquarters at Kansas City, Mo. Mr. Morgan began railroad work in 1890 as Assistant Engineer in locating and building the Northern Pacific in Montana and Idaho. Besides holding responsible positions on the Southern Pacific and Illinois Central, he served for three years as Engineer of the Illinois Board of Railroad Commissioners. He entered the service of the Chicago & Alton in 1899 as Assistant Engineer.

Mr. A. Th. Ornhjelm, Mechanical Engineer of the State Railways of Finland, recently favored us with a pleasant call. He has been in this country in connection with locomotives recently completed for those lines by the Baldwin Locomotive Works, and has also made a study of American railroad methods. He considers our locomotives particularly interesting because of their enormous power, but finds the finish and care in fitting rather disappointing. In Finland much is made of grinding-in and accurate fitting of parts. In car construction he received many important suggestions from our practice which appeared to be directly applicable to the conditions in Finland, where, heretofore, English methods in car design had been almost exclusively followed. The Norfolk & Western steel frame coal car of 80,000 pounds capacity, illustrated on page 100 of our April issue, appealed to him particularly as an example of merit in our practice which was suggestive and applicable in modified form for the use of the lines he represented. In visiting the car building plants of this country he was permitted by the courtesy of Mr. S. P. Bush and Mr. J. J. Hennessey to examine the car shop methods of the Chicago, Milwaukee & St. Paul at West Milwaukee. He was impressed with the system employed there, and considered it not inferior to those seen in the largest of the car building establishments of this country which he visited. Among other interesting matters concerning practice in Finland, where civil service rules govern appointments and promotions, he mentioned the fact that it was customary for young men to serve for a time as volunteers without pay before taking examinations for appointment to official positions. He himself had served two years in this way without compensation. Mr. Ornhjelm is a subscriber to the "American Engineer." His entire conversation indicated that foreign engineers are seeking more than ever before to inform themselves upon railroad progress in this country.

BOOKS AND PAMPHLETS.

The Boston Belting Co., 256 Devonshire St., Boston, have issued a little pamphlet entitled "Do You Know?" of 20 pages, containing a list of the mechanical rubber goods which they manufacture. It suggests the importance of this industry, which reaches into all lines of transportation and manufacture.

Proceedings of the South African Association of Engineers. Vol. V., 1898-1899.

This volume contains a discussion on Tests of a King-Riedler Air Compressor, Notes on Electric Lighting Supply, Isolated Winding Plant at Ferreira Mine, Three-Phase Electrical Transmission of Power, Notes on the Manufacture of Calcium Carbide, and the proceedings of the seventh annual meeting. Copies may be obtained from Eden Fisher & Co., 6 Clements Lane, Lombard St., London, E. C.

The Wm. Powell Company, 2525 Spring Grove Avenue, Cincinnati, Ohio, have issued a new catalogue and price-list "No. 7," giving information concerning their specialties used by engine builders, mills, furnaces, transportation companies and pipe fitters. It contains illustrations and information concerning a very large variety of valves, lubricators, oil feeders and grease cups. The importance of making valves with a view of regrinding is emphasized. Among the lubricators we note the patent "Star" duplex condenser and double "up-feed" locomotive lubricator which was illustrated on page 125 of our April issue. The pamphlet has 253 pages and is convenient for the pocket. It has a number of colored pages scattered through the book, with useful information concerning the use of steam, horse power of boilers and engines and the use of belting. This catalogue should be kept at hand by all who use steam specialties because of its scope and convenience.

"Colorado via the Burlington Route" is the title of a new pamphlet on Colorado just issued by Mr. P. S. Eustis, General Passenger Agent of the Chicago, Burlington & Quincy. The past year has brought out an unusual number of noteworthy railroad advertising publications, but this one surpasses them all in attractiveness. The whole work is in excellent taste and the production is a book so handsome that it will find its place among the nice things one likes to preserve. It has another and greater value as a guide to the wonderful attractions for which the tourist loves Colorado. The illustrations are well executed half-tones from the copyrighted photographs of the Detroit Photographic Company; the text is by James Steele, and these are combined with good printing and tasteful arrangement. Copies may be had by sending a request accompanied by six cents in stamps to Mr. P. S. Eustis, General Passenger Agent, 209 Adams Street, Chicago.

The Ball Bearing Co., Watson St., Boston, manufacturers of ball and roller bearings for all kinds of machine construction, shafting and vehicles, have issued a "Twentieth Century Catalogue" describing the forms of these bearings which are regularly manufactured and carried in stock. It is beyond the possibilities of a catalogue to show all of the forms they are prepared to make. With special machinery and a trained organization they are ready to take up any desired special work of this character. Among the illustrations we notice one of thrust collar roller bearings for heavy pressures which appears to be very desirable for cranes and turn-tables where heavy loads must be provided for in small spaces. The catalogue presents a surprising variety of bearings, and in connection with each size and style the working loads are given. The pamphlet is well printed and bound in durable flexible covers. The present activity of the company indicates that Mr. W. S. Rogers, the General Manager, has used his railroad experience very effectively in the two years of his connection with this concern. The work is now far behind the orders, and machinery soon to be installed will double the capacity of the plant. A recent addition of 10,000 square feet of floor area has been made to the factory. A large field for ball bearings is represented by an engraving of an automobile on the back cover of the catalogue.

Boston & Maine Publications.—In its mission of promoting and bringing New England into prominence as a vacation and tourist resort, the Boston & Maine Railroad endeavors to place before the public descriptive matter that is interesting, instructive and authentic.

The illustrations used in the various publications are from pictures taken expressly for the Boston & Maine Railroad by one of the most noted landscape photographers in the country and are veritable works of art.

Last year three portfolios were added to the list of illustrated publications which bear the following titles: "New England Lakes;" "New England Rivers" and "Mountains of New England." These portfolios contain half-tone reproductions 4 by 6 inches in size. For the present season two additional portfolios have been prepared, namely: "Sea Shore of New England," and "Picturesque New England" (Historical-Miscellaneous).

In the Sea Shore Portfolio, among the thirty odd views of the rugged New England shore is a distant outline of Grover's Cliff, at Beachmont. In the vicinity of Marblehead are pictures of the surf and of the ancient wharves and of scenes in the harbor; then there is a picture of the "Singing Beach" at Manchester on the North Shore. Gloucester affords a variety of scenic display which depicts harbor and shore scenes. Further down the shore are vistas of picturesque surroundings at Ipswich Bluff, in the vicinity of Newburyport and at Salisbury. Of Hampton Beach and the Isles of Shoals there are several views, as well as York Beach. Likewise of Kennebunk and Old Orchard there are several delightfully pleasing representations of familiar places.

The Picturesque New England Portfolio is indeed one of the most interesting of the series, as it treats of a variety of subjects with which all are acquainted. Pictures are shown of the birthplaces of Whittier, Hawthorne, Rebecca Nourse, Horace Greeley, and President Pierce, while the Revolutionary reminders include illustrations of the Munroe Tavern; the Monument and Minute Man Statue at Concord, Mass.; the Governor Craddock House at Medford; and General Gage's Headquarters. The Colonial period is suggested in a collection embracing illustrations of the Frary House, the Governor Wentworth Mansion and the Hannah Duston Monument. The rural districts are attractively displayed in numerous views of inland scenes in the vicinity of Hadley, Lancaster and Groton, Mass., and Charlestown, N. H.

Either one or all of these five portfolios can be obtained by sending six cents in stamps for each book to the General Pass. Dept., B. & M. R. R., Boston, Mass.

Les Moteurs a Explosion Etude a L'Usage des Constructeurs and Conducteurs d'Automobiles. Par George Moreau. Published by Librarie Polytechnique, Ch. Beranger, Editor, 15 Rue des Saintes-Pères, Paris, 1900.

This book is an elaborate mathematical study of small explosive motors, having particular reference to those for motor carriages. It is intended for mechanical engineers who are engaged in designing and constructing such motors. It contains a theoretical study of small internal combustion engines, a critical examination of their cycles, consideration of the power transmission from the pistons of the motors to the axles, the internal friction of these motors and machinery of motor carriages, a discussion of the operating parts of motors, including governors and transmission devices. A general chapter treats of the thermal values of gas and oil for motors and the quantities of air required for combustion. Another chapter deals with the power of motors, their heat losses, tests, road trials and races. The treatment of tests with conclusions upon which to base designs and the information for guidance in the design of these motors which the title of the book leads the reader to expect are not quite satisfying, but as a theoretical study with the deduction of formulas it is very successful.

EQUIPMENT AND MANUFACTURING NOTES.

McCord & Co. have moved their Chicago offices to 1475 Old Colony Building.

The Chicago Pneumatic Tool Co. have moved their New York offices from 122 Liberty Street, to No. 95 of the same street.

There are 8,000 regular employes on the rolls of the Baldwin Locomotive Works, and the present activity represents an output of 1,200 locomotives per year, or 4 for every working day.

Mr. Samuel B. Hynes has been elected Secretary of the Safety Car Heating and Lighting Co., with office in Chicago. He succeeds Mr. C. H. Howard, who has resigned to accept a position with another company.

The Detroit Graphite Mfg. Co., Detroit, Mich., have issued a card directing attention to the time and corrosion resisting properties of their "Superior Graphite Paint," particularly for the protection of exposed metal and wood surfaces.

The Chicago Pneumatic Tool Co. have been informed by Naval Constructor Belianskie of the Russian Navy that the new Boyer pneumatic drill has been very successful and satisfactory in submarine work upon the sunken battleship "Apraxin" of that navy. In an illustrated lecture by this officer before the Marine Society of St. Petersburg, upon this drill, this officer demonstrated that it will bore through granite and other hard substances under water as well as in the air.

In the article on "Rapid Transit in New York," which William Barclay Parsons, chief engineer of the Rapid Transit Commission, contributes to the May Scribner's, he says that, after the railway is built and the street surface restored, except at portions at the northern termini, where there are viaduct constructions, there will be scarcely any evidences of its existence. The only outward sign will be the glass-covered stairway approaches leading down from the sidewalks to the stations. Mr. Parsons makes the point that it should be called a subway, not a tunnel.

Mr. A. C. Hone, Superintendent of Motive Power of the Evansville & Terre Haute R. R., has extended the compressed air system at the Evansville shops for the purpose of spraying freight cars. Recent tests on this road of Lucol paint have proven very satisfactory. One coat of this paint is held to be equal to two coats of linseed oil paint, and as it dries out in 8 to 10 hours, cars are painted and stenciled in one day, thus saving the labor of the second coat of linseed oil paint and the detention of the car till the next day to put it on. The Vandalia R. R. at Terre Haute are also testing this paint.

About three years ago the Standard Steel Platform for passenger cars, designed by H. H. Sessions, was placed upon the market by the Standard Coupler Company. It is now in use on eighty railroads, besides being the adopted standard of the Pullman Company. The President of the Standard Coupler Co., Geo. A. Post, makes the interesting statement that, during the first three months of 1900, shipments of steel platforms have been made for application to equipment of railroads that, in the aggregate, operate in every state and territory of the United States, except Delaware, and as well in Canada and Mexico.

The Ashcroft Manufacturing Co., 85 Liberty St., New York, have issued a new catalogue which they have endeavored to make complete in every detail in illustrating and describing their well-known products. The Ashcroft pressure gauges, Edson pressure recording and alarm gauge, the Ashcroft revolution counter, the Keyser automatic water gauge, the Moscrop speed recorder and the Tabor steam engine indicator are included, and it is evident from this catalogue that this firm aims to keep abreast of the times in meeting new demands for devices in these and similar lines. The book is bound in buckram and is well printed and clearly illustrated. It has an index.

Railway Motor Engineering is a new course of instruction offered by the International Correspondence Schools, Scranton, Pa. The course was prepared and is being kept up to date by Eugene C. Parham, Superintendent of the Nassau Division of the Brooklyn Rapid Transit. It is intended for operators and those who wish to become operators of electrical machinery and contains practical instruction on the operation and maintenance of electric cars and motors. As instruction is carried on by mail, it affords means for acquiring valuable information without obliging students to lose time from work. The International Correspondence Schools were established in 1891 and have nearly 100 courses and over 165,000 students and graduates.

An impressive demonstration of the effect of "Cling-Surface" in a recent emergency in an electric railway power house is described by the Editor of the Sibley College Journal of Engineering, Cornell University. He, with others, was making electrical tests under the direction of Professor Carpenter of Cornell at the power house of the Buffalo (New York) Street Railway. While the tests were progressing it was snowing, according to the account, at the rate of six inches an hour. An ice jam had formed in the Niagara River, and the power from Niagara Falls was shut off, compelling the railway company to do its storm work with power from their own engines alone. These were forced to the utmost. The belts strained and groaned, and ran with a great deal of slack in their nondriving sides. All the belts held except one. That one was dry and hard, with a shiny, glassy surface, while the others which did not slip had been treated with Cling-Surface.

The Chicago Pneumatic Tool Co., manufacturers of the Boyer and other pneumatic tools, have issued a unique pamphlet of 158 pages containing reproductions of testimonial letters from firms who are using these tools. Such an array of favorable testimonials has never before been brought to our attention. The appreciation of these tools, expressed in these letters, is convincing evidence of the high position they have taken because of their labor-saving possibilities. In some cases several letters from the same firm testify to continued use and satisfaction. The letters refer to different appliances and the high standing and prominence of the firms gives weight to their favorable opinions of which any manufacturers supplying them should be proud. This pamphlet contains nothing but these letters. It is a convincing argument in favor of the tools. They have brought about a revolution in methods of building and repairing boilers, ships, locomotives and work of similar character. Many of the letters mention this fact.

An exhibition was recently made at the Art Museum, in Springfield, Mass., of the results of work done by local students in the International Correspondence Schools of Scranton, Pa. This exhibition was of special interest as showing how far comparatively uneducated people may progress by improving spare moments in the study of lines of work in which they desire to perfect themselves. The Correspondence Schools interested in this exhibition have a remarkable following in that city, over 600 persons being enrolled there. The work covers almost every line in which working people are interested. An ambitious young man who has been forced to slight his common-school education turns to the courses offered by these schools, and, selecting the one in which he is most interested, begins the study. The plan of the courses pre-supposes only the ability to read and write. The first work is elementary and the progress is gradual and possible only by becoming perfect in what has preceded. The student goes through the course and at such a time as he completes the work receives a diploma, and the management of the schools is also interested in securing for the graduate better employment in keeping with his proficiency. The exhibition was made in Springfield at the suggestion of the City Library Association.

AMERICAN ENGINEER AND RAILROAD JOURNAL.

JUNE, 1900.

CONTENTS.

ATLANTIC TYPE FAST PASSENGER LOCOMOTIVE.

PENNSYLVANIA RAILROAD.

Class E 1.

(With an Inset.)

The highest development in passenger locomotives on the Pennsylvania and probably the best example of painstaking design is the Class E 1, Atlantic type, of which three were built last year at the Juniata shops, Altoona, and put into the Atlantic City service last summer. These engines won the admiration of one of our best-known locomotive builders, who recently referred to them as "the best workmanship ever put into locomotives in this country." They are more noteworthy, however, as representing a design the object of which was to secure the highest possible speeds in very fast passenger service of a special character and to develop the maximum capacity of the single-expansion engine in this work. It is not believed that the ultimate has been reached and, while the type in its present form may not become a generally adopted standard, its success seems likely to exert a marked influence on future design on this road and to have a tendency to bring about a change of opinion with reference to boiler construction and the design of details on other roads.

The necessity for burning a large amount of fuel, whether anthracite or bituminous, was recognized, and to do this with reasonably low rates of combustion, large grates were used. The grate area is nearly 70 square feet, which appears to be ample for the conditions to be met, and experiments are now being made by blocking off portions of the grates to show whether or not this may be reduced in future construction in order to secure a cab arrangement which will bring the engineer and fireman together. The large grates have already shown the advantage of flexibility in the selection of coal and the importance of large grate areas in obtaining great power for relatively long periods. We believe that locomotives have never been designed with greater care than these. This was due to the Pennsylvania way of working and to the special attention which was required by the radically new features in their practice in this case. The details of construction, the size and form of the steam passages and the study of the valve motion are specially interesting features, all of which, added to the boiler power, contribute to the satisfactory performance.

The engines were intended specially for the Atlantic City service from Camden to Atlantic City, and with trains of about 300 tons the engineers state that they have not yet reached speeds at which the boilers failed or showed signs of failing in steaming capacity. March 29, last, engine No. 820, the one we illustrate, hauled 7 cars from West Haddonfield to the Atlantic City drawbridge, 51½ miles, in 47 minutes, an average speed of 65.7 miles per hour. The distance from Hammonton to the drawbridge, 27.4 miles, was covered at the rate of 74.7 miles per hour. The same run was made last July with engine No. 698 with a train of 8 cars and the dynamometer car, the combined weight of which was 308 tons, at the same average speed. The average drawbar pull was 4,130 pounds and the drawbar horse-power was 822, as measured from the dynamometer. The maximum speed with this train was 79.9 miles per hour. These records were made in regular service and not with a view of showing the limits of speed; these have not been reached and are not required by the present schedules. It may therefore be said that the capacity for high speed is not yet known. The schedule for last year called for an average speed of 63.6 miles per hour from Camden to Atlantic City, 58.3 miles, and there was not the slightest difficulty in making it.

On page 22 of our January number of the current volume we printed a general description of these engines and now present the most interesting of the details. The principal dimensions are as follows:

PENNSYLVANIA R. R.

Class E 1, Atlantic Type.

Weight on truck in working order	38,125 lbs.
Weight on first pair of drivers	50,250 lbs.
Weight on second pair of drivers	51,300 lbs.
Weight on trailing wheels	33,775 lbs.
Weight on engine in working order	173,450 lbs.
Tractive power per pound of m. e. p.	136.6
Tractive power with e. m. p. equal to 4/5 boiler pressure	20,214
Number of pairs of driving wheels	2
Diameter of driving wheels	80 in.
Size of driving axle journals	9¼ in. and 8½ in. by 13 in.
Length of driving wheel base	7 ft. 5 in.
Total wheel base of engine	26 ft. 6½ in.
Total wheel base of engine and tender	50 ft. 5 in.
Number of wheels in engine truck	4
Diameter of wheels in engine truck	36 in.
Size of engine truck axle journals	5½ by 10 in.
Spread of cylinders	85½ in.
Size of cylinders	20½ in. by 26 in.
Steam ports	1½ in. by 20 in.
Exhaust ports	3 in. by 20 in.
Travel of valve	7 in.
Lap of valve	1½ in.
Type of boiler	Belpaire wide firebox
Minimum internal diameter of boiler	65⅞ in.
Number of tubes	353
Outside diameter of tubes	1¼ in.
Length of tubes between tube sheets	156 in.
Fire area through tubes, square feet	4.5
Size of firebox, inside	102 in. by 96 in.
Fire grate area, square feet	68
External heating surface of tubes, square feet	2,102.4
Heating surface of firebox, square feet	218.0
Total heating surface of boiler, square feet	2,320.4
Steam pressure per square inch, pounds	185
Number of wheels under tender	6
Diameter of wheels under tender	42 in.
Size of tender truck axle journals	5 in. by 9 in.

Boiler.

The boiler, which is 65⅞ in. in diameter at the front end, is straight on top and combines a wide firebox and a combustion chamber with Belpaire staying. This method of staying is a favorite on this road, although it has been departed from in later designs in order to save weight and space in the cab. The firebox is 8 ft. long by 8 ft. 6 in. wide, which is believed to be the widest grate ever used. There are two fire-doors; one would not permit of firing such a wide grate. The combustion chamber is 3 ft. 3 in. long and is flat on top and bottom. Large water spaces are provided around the combustion chamber and particularly under it, where the opening is about 8 in. deep. The combustion chamber outside sheet has cross stays bearing on bosses made by flanging the sheet outward as shown in Fig. 5. There are seven of these stays fitted with copper washers and cap nuts. The combustion chamber is separated from the firebox by a brick bridge wall.

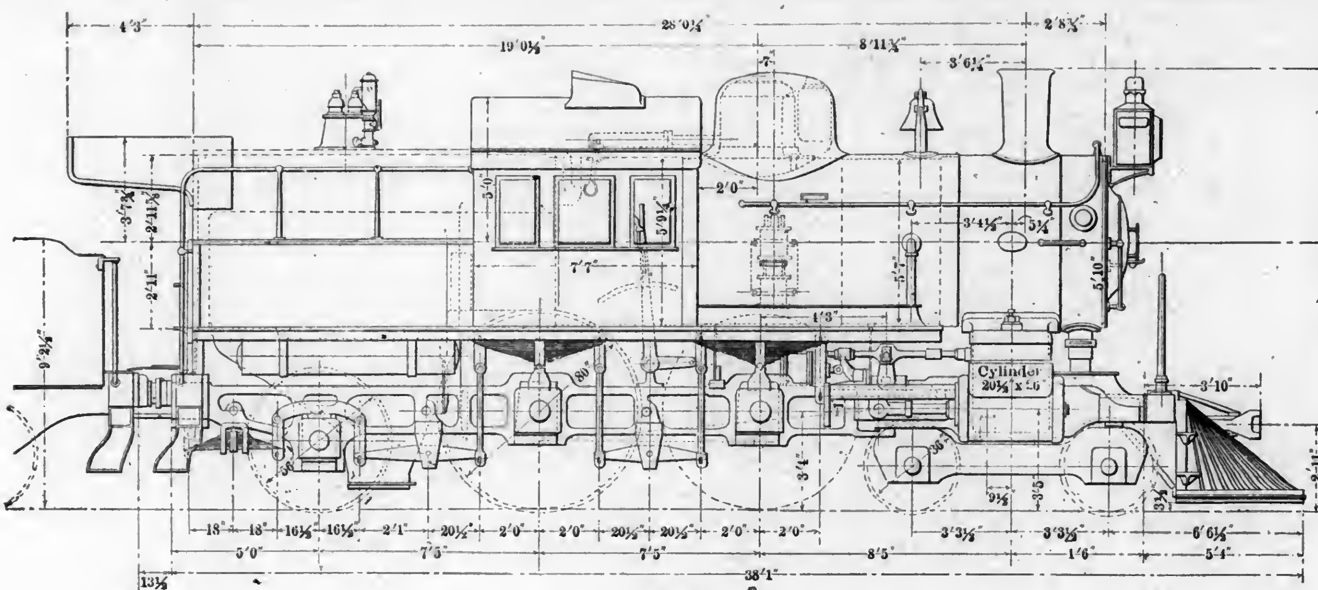


Fig. 1

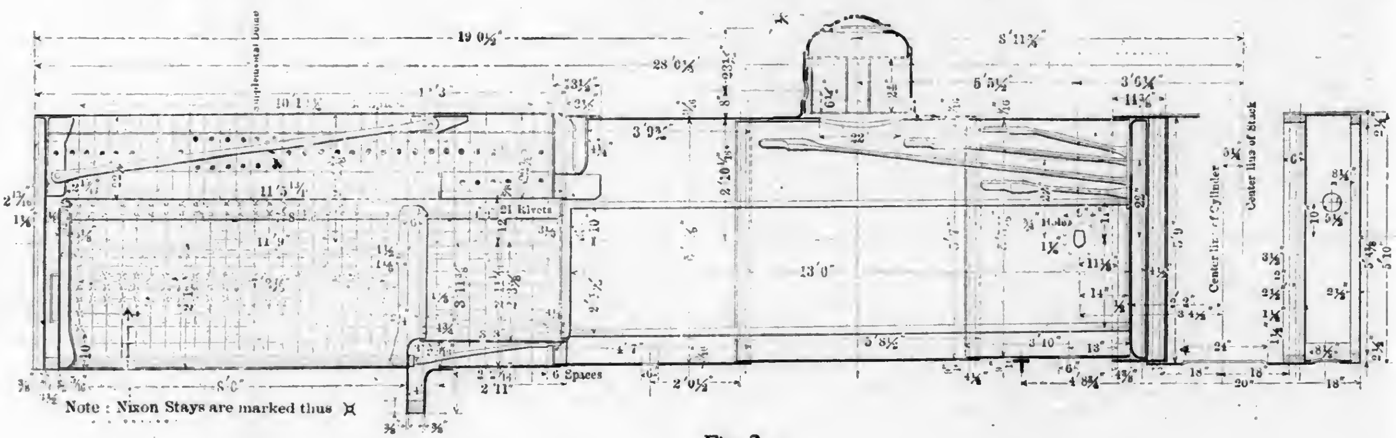


Fig. 2

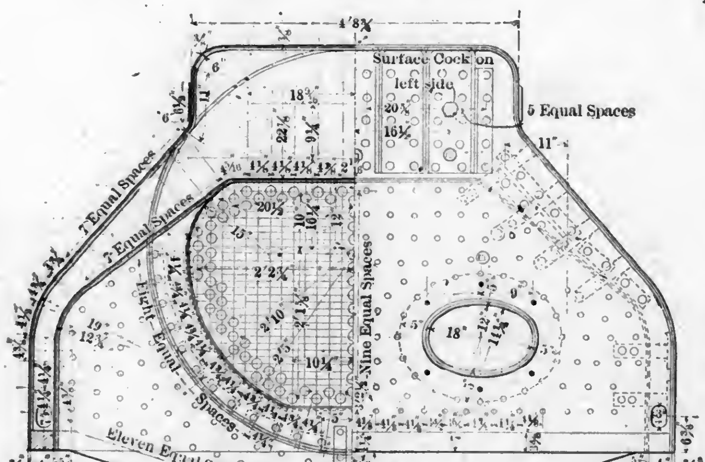


Fig. 3

Fig. 5

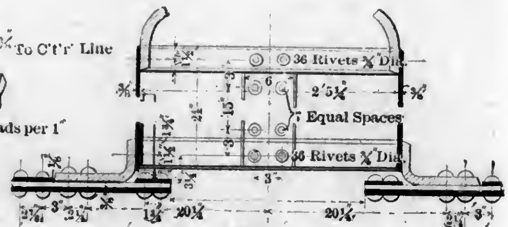


Fig. 4

The tubes, 353 in number, are 1¾ in. in diameter, 13 ft. 1 in. long, which is a ratio of 104 calibers inside, and 86 outside. About 90 calibers was desired. The heating surfaces, weights and thicknesses of sheets are as follows:

External heating surface of tubes	2,102 sq. ft.
Heating surface, firebox and chamber	218 sq. ft.
Total heating surface	2,320 sq. ft.
Fire area through tubes	4.5 sq. ft.
Total weight of boiler	37,494 lbs.
Weight of tubes	8,671 lbs.
Thickness of shell sheets	9/16 in.
Thickness of side sheets	5/16 in.
Thickness of crown sheets	⅜ in.
Thickness of outside roof sheet	⅜ in.
Thickness of outside side sheets	⅜ in.

The sheets are thin and they should therefore be expected to favor the durability of the staybolts. "Nixon" stays are used at the points marked with crosses in Fig. 2. The back head has outward flanging and is stayed with rods secured to the head by means of feet of steel plate made in box form. These act as gussets and their flanges stiffen the sheet. Where the diagonal stays cross the laterals, the laterals are doubled to avoid interference. The mud ring is 4 in. wide at the front and sides, reduced to 3½ in. at the back end. The crown sheet is continuous, extending in a single plate from the back end of the firebox to the front end of the combustion chamber, the roof sheet being made in the same way. The roof sheet is 12 ft. 3 in. long and the length of the crown sheet is 11 ft. 5 in. The dome is cylindrical with a curved dome saddle.

Grates and Ash Pan.—The grates are in four sections, each with a separate shaking bar at the back head. The grates are straight across the back end with a dip toward the center, increasing in depth toward the front. They are supported at the sides by castings bolted to the firebox sheets, as shown in Fig. 8. These castings also extend across the front and back ends and carry the longitudinal central bearing bars

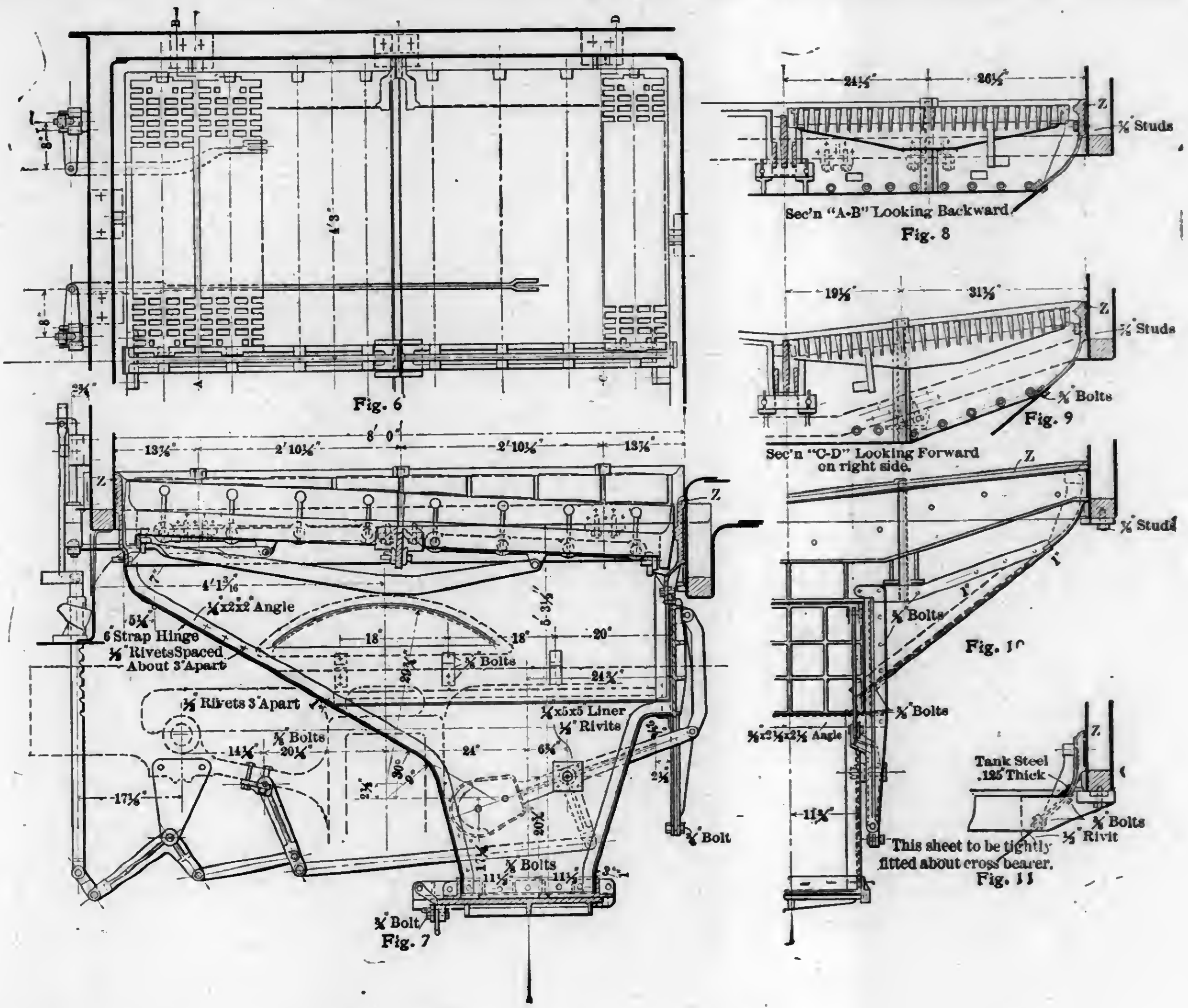


Fig. 6

Fig. 7

Sec'n "A-B" Looking Backward.
Fig. 8

Sec'n "C-D" Looking Forward on right side.
Fig. 9

Fig. 10

Fig. 11

which are supported at the center of the firebox by the cross bearing bar. The grate bearing castings make tight joints with the firebox sheets against asbestos rope and they extend below the grates to carry the ash pan. The ends of the grate bars have sockets fitting over projections on the bearers in such a way as to protect the bearings from accumulations of ashes. The cross bearer is lipped over a boss forged on the under side of the mud ring and acts as a lateral brace at the center of the firebox as seen in Fig. 11. This figure also shows the bonnet placed over the end of the cross bearer where it passes through the ash pan. The grates have about 50 per cent. of air space and are intended for both anthracite and bituminous coal.

The ash pan is of ¼-in. tank steel put together with ¼ by 2 by 2 in. angles and carefully fitted to be air tight. The joints with the firebox sheets are made with asbestos rope to prevent air from getting in at the sheets and creating "blow-pipe" flames against the sheets. The pan was made as deep as possible in order to secure large volume and the ashes are dropped through a cast iron slide without the necessity of raking them down. This slide is locked in the closed position by pawls shown in Fig. 7. The air dampers of wide firebox engines are usually placed at the rear ends; in this case it is in front, and in the form of a cast iron plate which is counterbalanced and is dropped in a guiding frame in opening. Safety hangers are placed over the frames to hold the ash pan in case of breakage of the bearing castings. In many ways the ash pan, and particularly the air admission features, have had an unusual amount of attention. They deserve more than is usually given them.

Smokebox.—The "front end" has a comparatively short extension and does not follow the Master Mechanics' Association

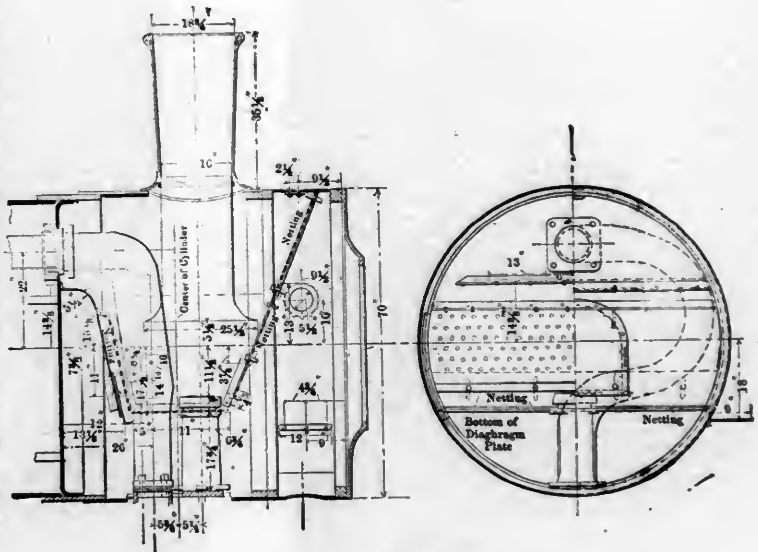


Fig. 12

recommendations as to arrangement. The nozzle is 17¾ ins. high below the tip and the stack is extended down to within 17 ins. of the top of the nozzle. It will be noticed in Fig. 12 that the center of the saddle is back of the center of the stack and that there is but one steam pipe, which is placed in the "wake" of the exhaust pipe. The arrangement of the parts is clearly shown in this engraving.

Cylinders and Saddle.

The cylinders are separate from the saddle, the arrangement and the fastening being similar to that of the freight engines

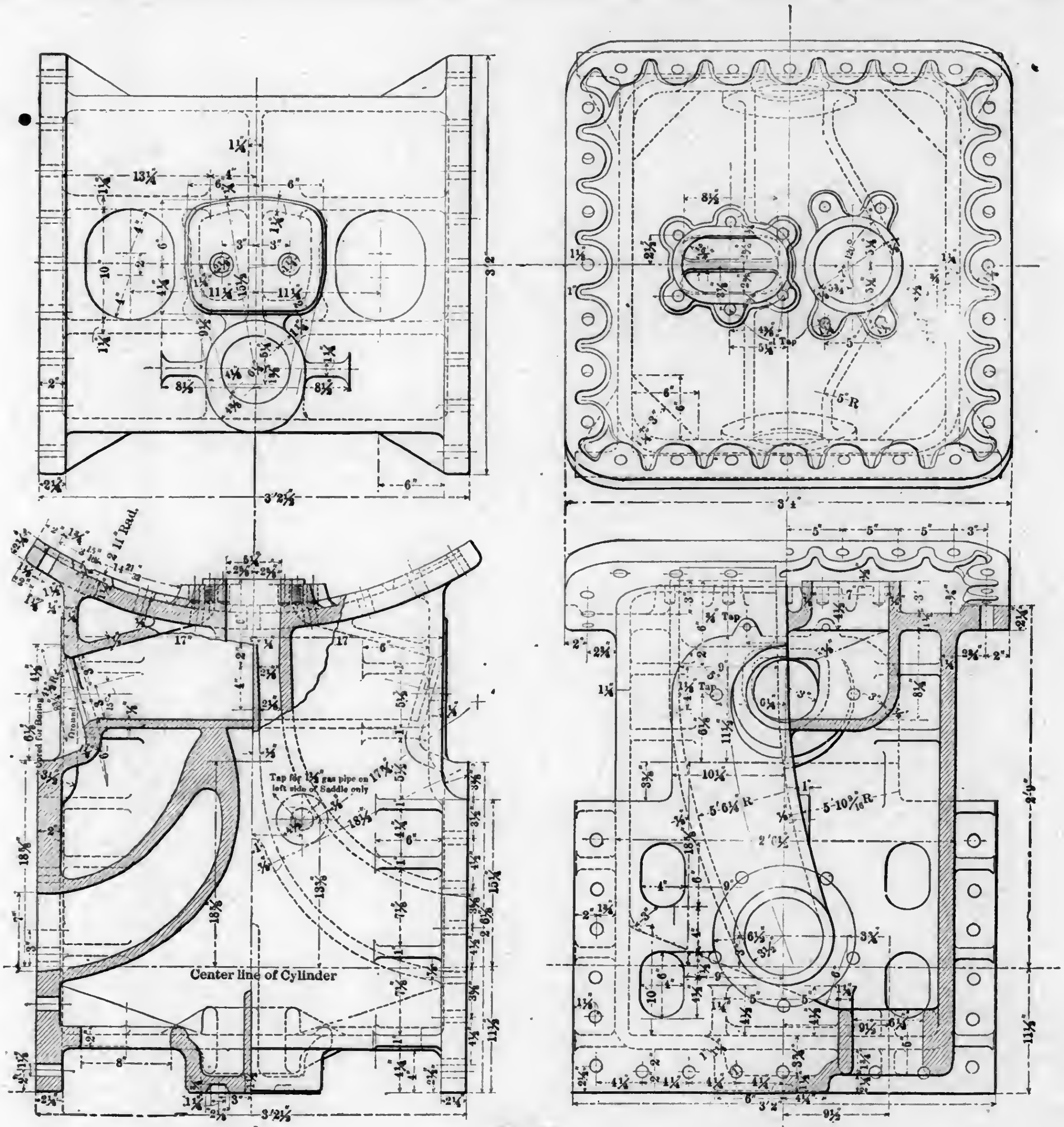


Fig. 13

illustrated last June. The saddle is illustrated in Fig. 13 and the cylinder in Fig. 14. A steam passage extends across the saddle. To this the single steam pipe connects, and between the saddle and each cylinder a short connecting piece, or "three-legged stool," Fig. 15, takes the steam into two 4½-in. openings into the cylinder. There is not room for one large connection, owing to the closeness of the steam chests to the saddles. The exhaust passes through a hole in each frame. In Fig. 14 the method of blocking off the corner or pocket under the outer end of the exhaust port is shown. This engraving also shows a third cylinder cock to drain the steam passage. The steam opening has an area of 30 square ins. and that of the exhaust pipe is 38½ square ins. The bridges have large fillets for protection against breakage, while their width is 1¼ in., which is rather less than usual. The steam passages are ample and are not restricted beyond the end of the dry pipe, as is often the case. The exhaust pipe is contracted so that the choke is 6 ins. below the top of the saddle casting, as shown in Fig. 13. With a large boiler located high to clear the driving wheels the outside stack has to be short so as not to exceed the clearance limits, consequently the stack had to be extended downward in the smoke box, which in turn shortens the exhaust pipe, and therefore, in order that the exhaust jet shall have a chance to straighten up, the bridge was placed as far as possible below the nozzle. The area at the bridge is about 18 square ins. on each side, which is about 70 per cent. of the opening of the 5¾-in. tip. The exhaust passages have easy curves and are free from pockets. The saddles have large chipping areas and the bolts are kept away from the corners. The location of the center pin bearing, 9½ inches back of the center of the saddle, will be referred to in connection with the truck.

Frames.

One of the three engines had cast steel frames, the others being of wrought iron, except the front sections, which are of cast steel in all cases. The form, including the deep slab at the cylinders, Fig. 16, is similar to that of the freight engines illustrated last year, except that the upper rail is set down behind the driving boxes in order to make the firebox as deep as possible, and the frames of Class E 1 provide for the hanging of the brake apparatus without requiring castings for the bearings. The splices and cylinder joints are made tight by keys which are planed in pairs to insure accuracy of fitting, and they are arranged in such a way as to be in compression rather than in shear. The slab at the cylinders is 24¾ ins. deep and that at the foot plate is 13¾ ins. deep. The bear-

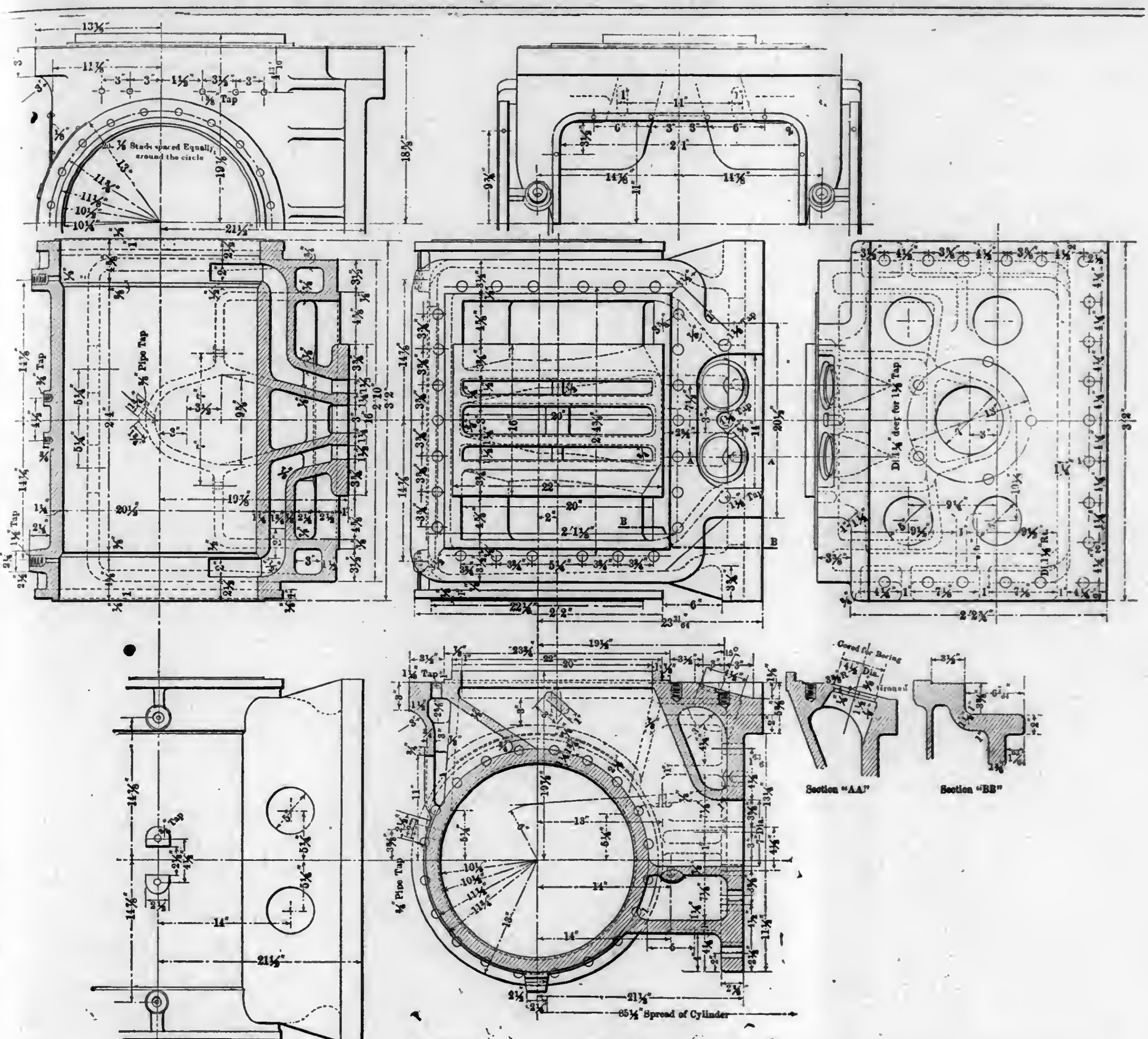


Fig. 14

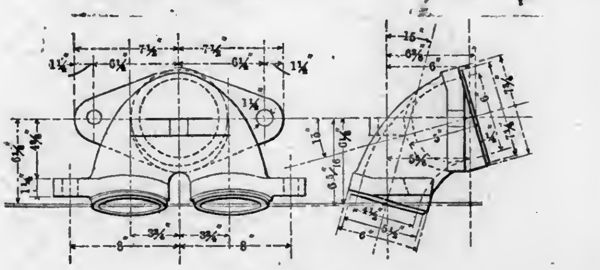


Fig. 15

ings at the lugs are cut away on the saddle side for a space on each side of the neutral axis in order to prevent rocking of the saddle at the joints in case they should be tightest at the center. This road has within the past two years equipped about 175 engines with this arrangement of cylinders separate from the saddles without a single instance of loosening in service. Vertical stiffness and rigidity of connection to the cylinders and foot plate are noteworthy features. The equalizing system is shown in Fig. 17, in which the equalizer between the rear drivers and the trailers is shown to be non-symmetrical. This was done in order to reduce the weight carried on the trailers. Safety hangers are placed under the rear springs. To guard against the loosening of the connection between the rear ends of the frames a foot plate, Fig. 18, in the form of a pressed steel box girder with three webs, was used. Usual construction employing bars with joints which are difficult to make tight has been entirely abandoned on this road in favor of a stiffer and more easily fitted arrangement, which adds weight but gives the rigid connection, which is so important in powerful engines to resist the tendency for the frames to work loose at the rear, resulting in throwing the stresses to the smokebox and cylinder connections. The coupling between the engine and tender is closed against a coiled spring, tending always to prevent the destructive jerks of couplings having even a small amount of lost motion. Immediately back of the rear driving boxes vertical ribs in the frames are finished to receive the ends of a 7-in. steel cross brace to which the front diaphragm plates are bolted to support the firebox at the front water leg. At the back end the boiler is supported by plate expansion braces.

Running Gear.

Pistons and Piston Rods.—With the exception of changing the sizes to suit the requirements, the pistons and piston rods are similar to those shown on page 182 of our June issue last year. The pistons are widened to 5 ins. over an angle of 120 degrees at the bottom, to increase the bearing area on the cylinders. This is considered as equivalent to the extended piston rod. Experience with the freight engines has shown the value of the precautions taken to permit of close fitting

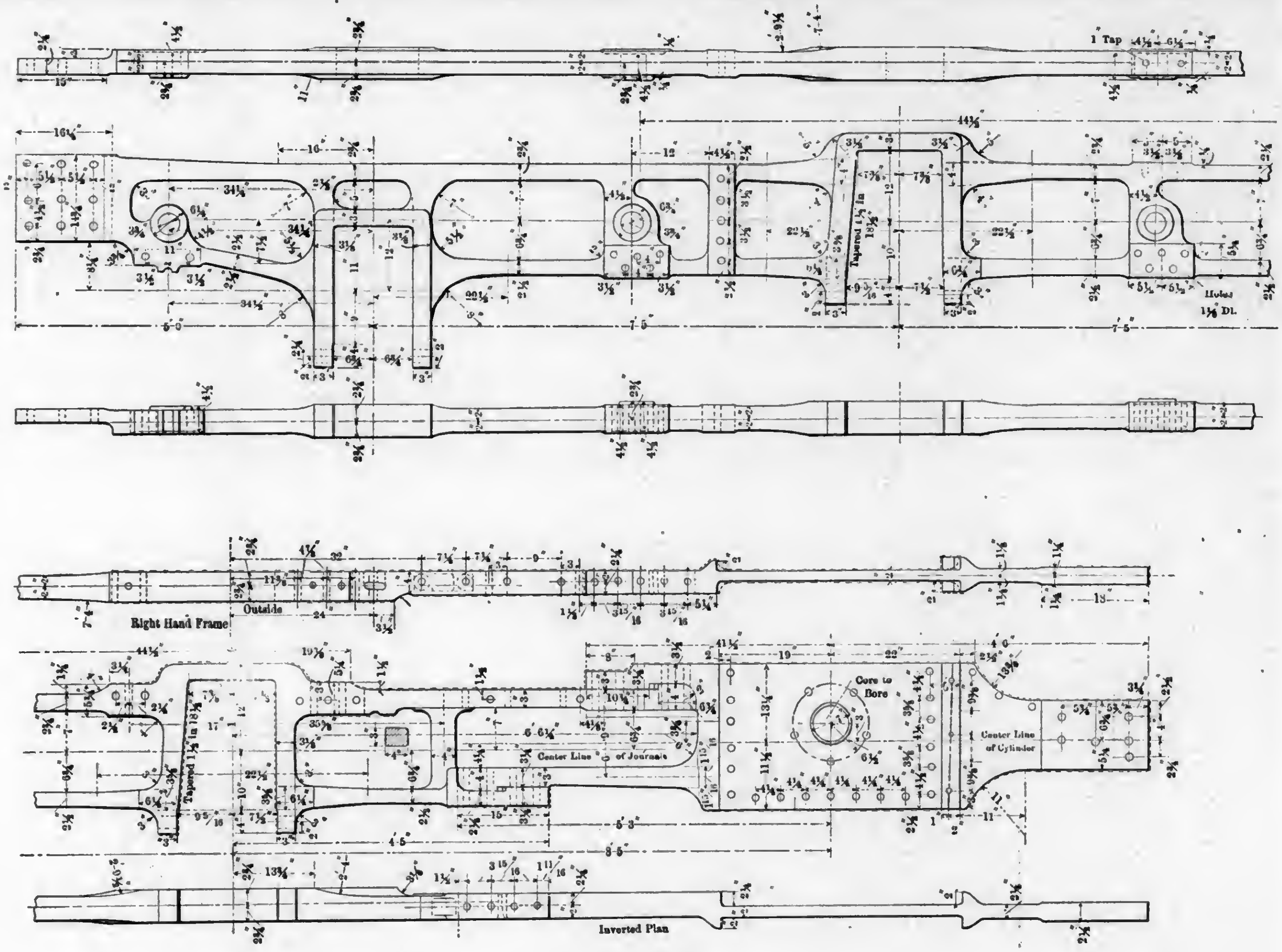


Fig. 16

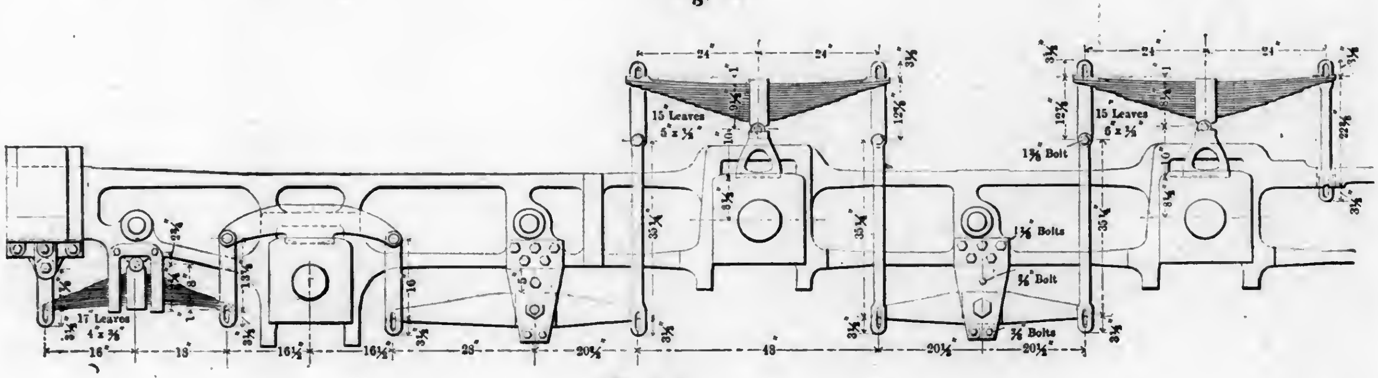


Fig. 17

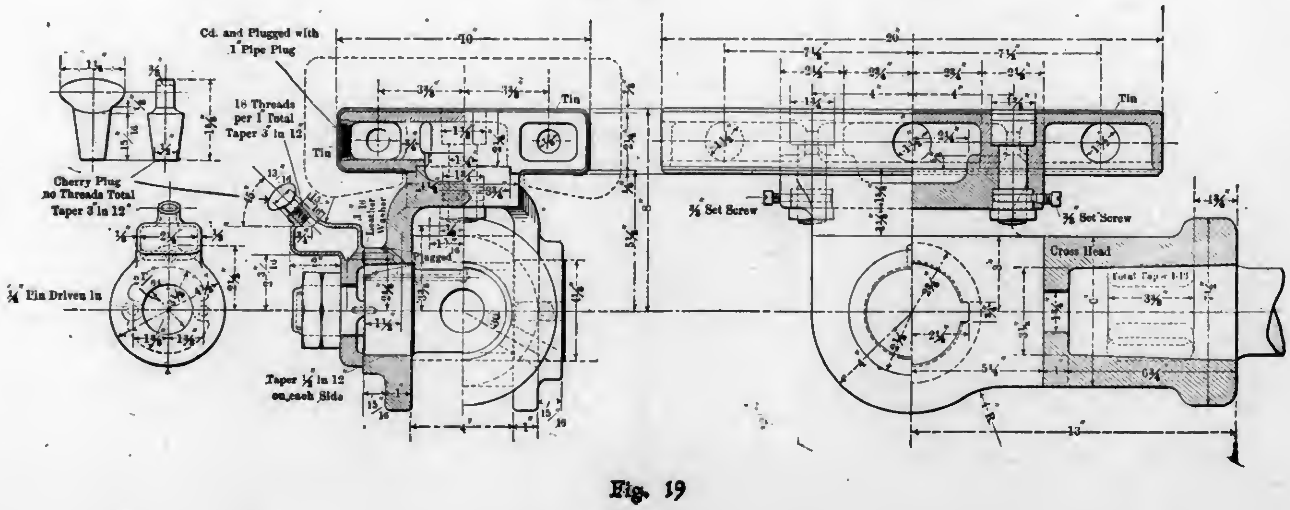


Fig. 19

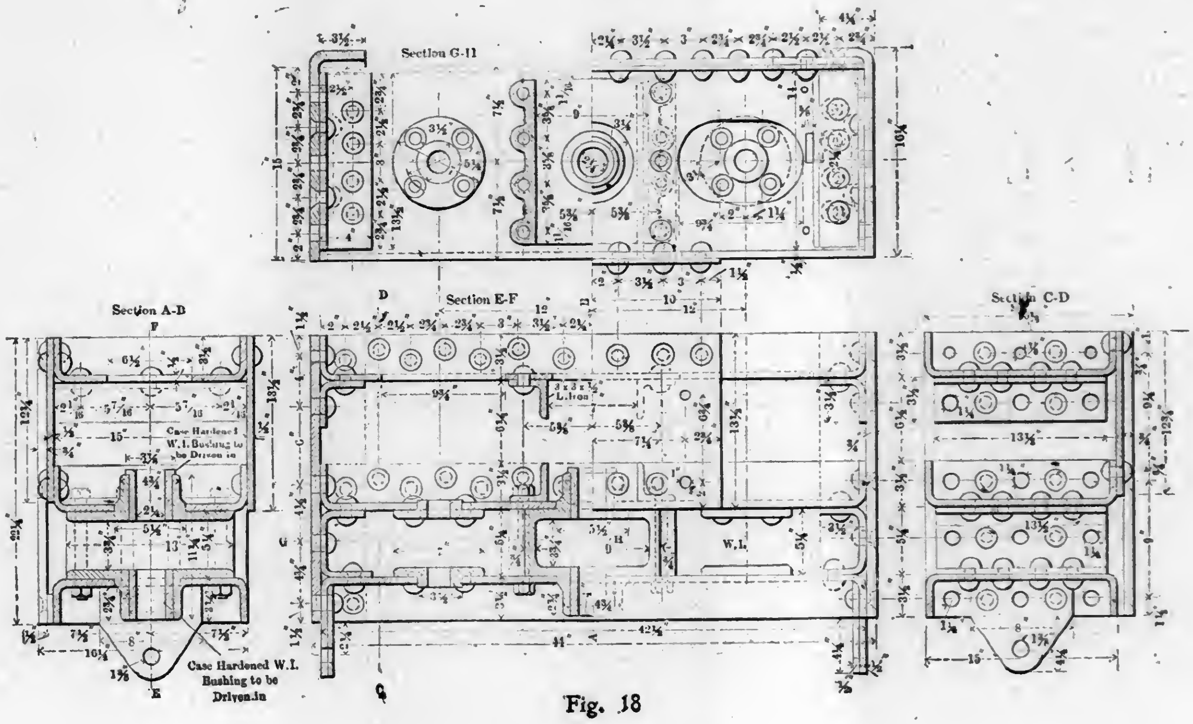


Fig. 18

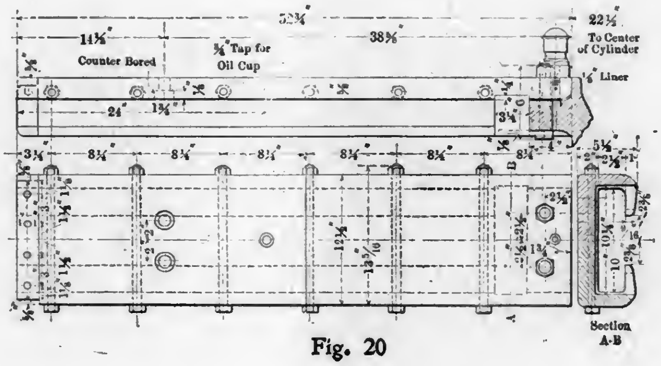


Fig. 20

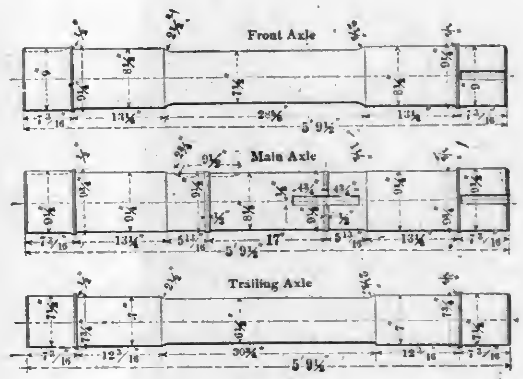


Fig. 21

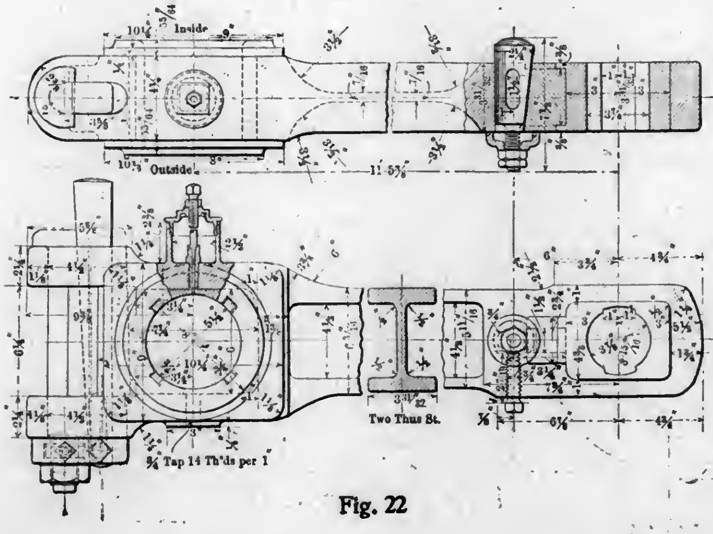


Fig. 22

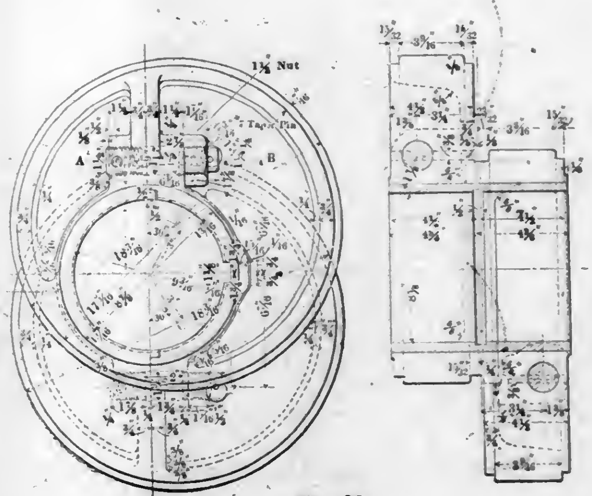


Fig. 25

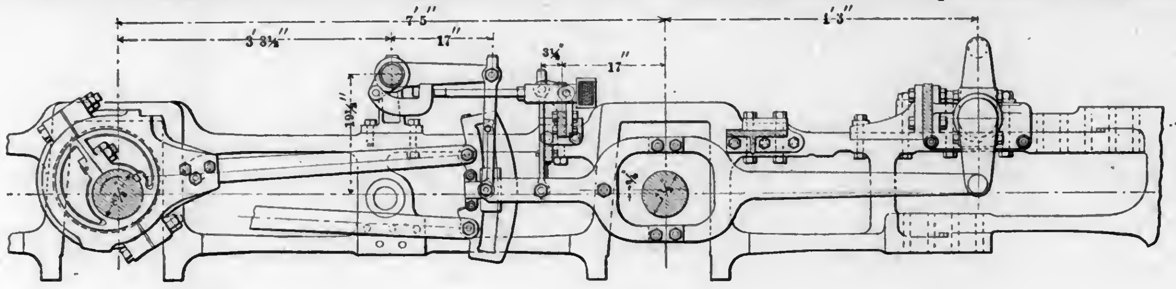


Fig. 23

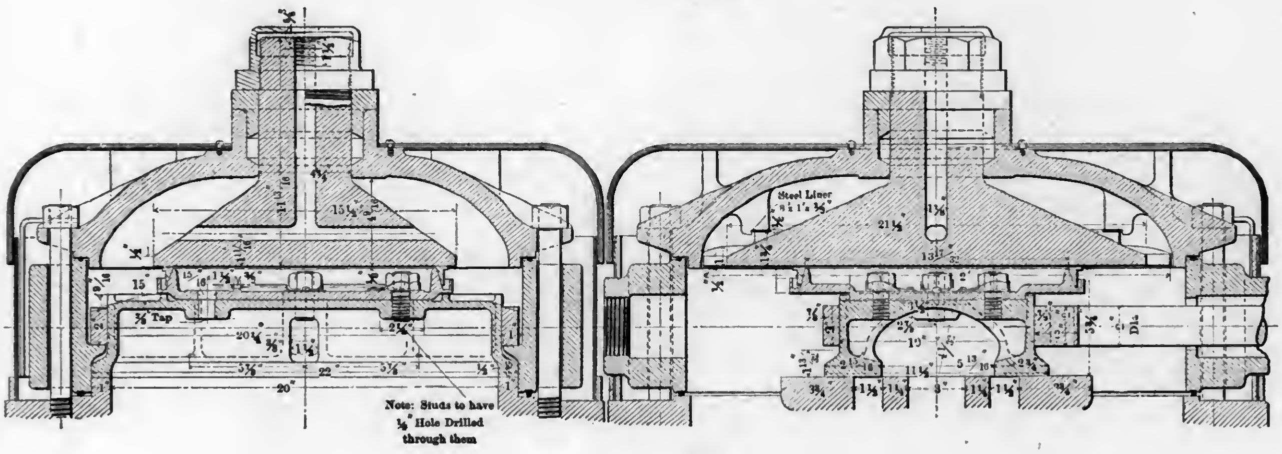


Fig. 24

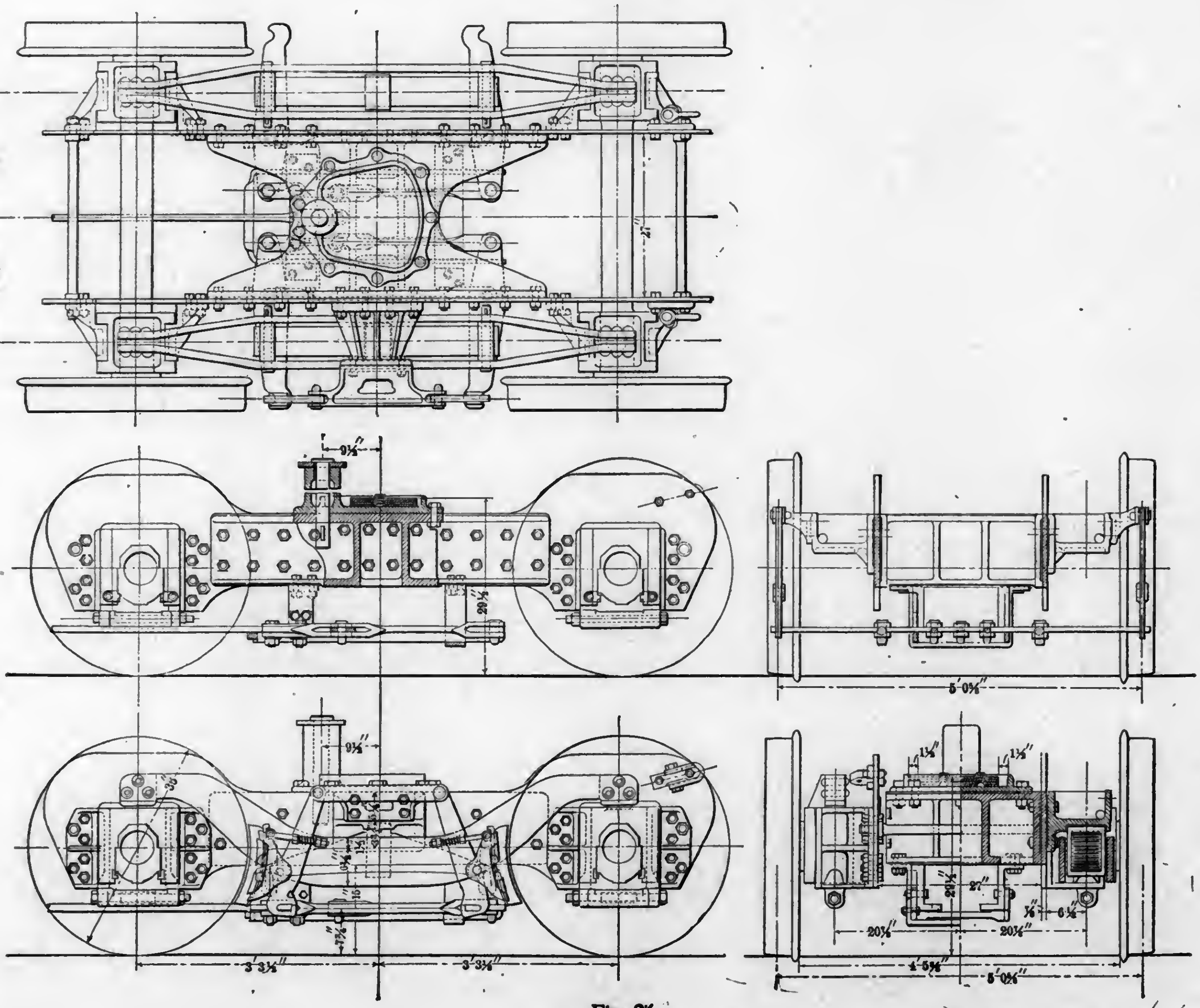


Fig. 26

of the piston rod at the crosshead end, and in order to prevent the crosshead fit from being tightest at the center the bearing is confined to the ends of the fit by cutting away the central portion. This feature, together with the enlarged ends of the rods, has overcome breakage of piston rods.

Crosshead and Guides.—The Vogt enclosed guide is used in connection with a very light cast steel crosshead, Fig. 19, made with the slipper and head integral. The slipper is tinned on top and bottom and sides. From the top face of the slipper to the center of the pin is but 8 ins. This design wears well and permits of reducing the weight of the reciprocating parts. An oil cup is cast as a part of the washer and the oil is delivered to the flat or non-bearing portion on top of the wrist pin. No stiffening ribs are required on the guides, which are of cast iron and 10 ins. wide, because of the location of the guide yoke. The guides are shown in Fig. 20.

Axles.—Very long journals, 13¼ ins., enlarged wheel fits and unusually large fillets are the principal features of the axles. Fig. 16, page 183 of our June issue, 1899, illustrates the cutting of the key ways, and Fig. 21, herewith, shows the dimensions of the axles of Class E 1 engines. The main journals are 9¼ by 13¼ ins., and those of the front axle are 8½ by 13¼ ins.

Main and Side Rod.—The rods are of steel, milled out, the side rods having solid ends and a 4 by 5¾ in. I-section with a ⅜-in. web and ⅝-in. flanges. This wheel arrangement required main rods 11 ft. 5⅜ ins. long, the construction being shown in Fig. 22. At the front end the brass is cut out at the top and bottom to correspond with the flat portions of the crosshead pin. This was first used on class P engines in 1894 and has been satisfactory. At this end more metal is provided at the bottom of the rod where the section is weakened by the set screw hole. The crank end is open at the back, and, instead of using a bolt through a block at the back of the brass and a key in front of it, a U-shaped block is placed back of the brass with its flat portion bearing against the brass. The projecting ends of the rod take a semi-circular gib which is threaded for a nut on its lower end to hold it tight. The key passes between the gib and the U-shaped block. The object of this arrangement was to prevent a difficulty sometimes occurring with the block and bolt of the older form caused by excessive setting up of the key, which led to the bolt being partly offset at the joint surfaces between the block and the rod, thus making it exceedingly difficult to remove the bolt and absolutely ruining it for further use. Moreover, this arrangement reduces the change in length of rod to a minimum, since both keys in the rod are behind the brasses which they close. A keeper is held by the nut on the gib and it serves as a nut lock and holds a set screw for the key. This arrangement is favorable to accurate fitting, it is strong, and may be easily taken down.

Valves and Valve Motion.

Valves.—These are of the American balanced type, Fig. 24, with a modification of the usual arrangement of the pressure plate. The valve is recessed on top for a bearing surface for the balancing disc and is scraped for tight fitting. In accordance with a suggestion by Mr. J. T. Wilson of the American Balance Valve Co., the bolts are relieved from the duty of driving the plate, this being done by the valve itself. The pressure plate, which is practically a beam of uniform strength, is held to the chest cover by a single large nut, bearing against a gland, and vertical adjustment is provided by means of liners between four bosses on the plate and corresponding lugs on the cover against which the pressure plate is drawn by the nut. These liners also serve to prevent rocking. The balance plates are 15⅛ ins. outside diameter. Lubrication holes through the pressure plate discharge oil at each end of the valve. The valve yoke rests on shelves at the sides of the steam chest and its weight does not rest upon the valve.

Valve Motion.—Except as to dimensions, the valve motion is similar to that of Class H 5 and H 6 engines. The top of the link is prolonged to give several extra notches in the quadrant to increase the starting power. This is clearly shown in Fig. 23. When in their lowest position the links cut off at 83 per cent. of the stroke, and when the block is opposite the upper eccentric rod pin the cut-off is 75 per cent. This gives a better turning moment and greater power in starting, which is very desirable with 80-in. driving wheels. The back end of the valve stem has a well designed phosphor-bronze guide and the motion of the rocker pin is transmitted through a block and crosshead, shown in the photograph. The rocker shaft is like that of the freight engines, but is made hollow and the ends of the hole are closed with gas pipe plugs. The rocker shaft has two phosphor-bronze sleeves cast upon it. The eccentrics are of cast iron, made with the rear halves and front halves of each pair cast in one piece. The bearing on the axle is 9½ ins. long and at the center a groove is cut to fit over a collar on the axle. They are secured by keys and the bolts are in tension only; the bolts are on opposite sides of the casting, as shown in the sectional view of Fig. 25.

Valve Setting.—The eccentric throw is 6 ins., the maximum valve travel is 7⅛ ins. in forward motion and 5⅝ ins. in back motion. The lead is 3/32 in. negative in full forward gear and 1/32 in. negative full back gear. The bridle pin is offset 19/32 in. The valves have 1/16 in. inside clearance at the front ends and ¼ in. at the back ends and 1½ in. outside lap at both ends. The cut-off readings taken from engine No. 698 are as follows:

Reverse lever notch.	Cut Off.							
	Forward motion.				Backward motion.			
	Right side.		Left side.		Right side.		Left side.	
	Front.	Back.	Front.	Back.	Front.	Back.	Front.	Back
	in.	in.	in.	in.	in.	in.	in.	in.
1	21 9/16	21⅝	21⅝	21⅝	18 13/16	19 1/16	18 15/16	19⅛
2	21	21 1/16	21 1/16	21	17⅞	18 1/16	17 13/16	18 1/16
3	20½	20 7/16	20½	20½	16 11/16	17	16 11/16	17
4	19⅝	19¾	19 11/16	19⅞	15 7/16	15¾	15 5/16	15⅝
5	18¾	18 15/16	18⅞	19	13 11/16	14¼	13 11/16	14¼
6	17 13/16	18 1/16	17 15/16	18⅛	11 13/16	12⅝	11 15/16	12 9/16
7	16 11/16	17	16⅝	17⅛	9 13/16	10 9/16	10 1/16	10¾
8	15 5/16	15⅝	15 5/16	15 13/16	7 13/16	8 15/16	8	8¾
9	13 13/16	14¼	13 11/16	14⅜	6⅛	6¾	6⅛	6⅞
10	12⅛	12⅝	12	12⅝	4 9/16	5	4½	5
11	10 3/16	10⅝	10	10⅝	3 5/16	3½	3 3/16	3 11/16
12	8¼	8½	8¼	8 5/16	2¼	2⅜	2⅛	2 7/16
13	6⅜	6⅜	6⅜	6⅜	1 5/16	1 9/16	1½	1½
14	4⅝	4½	4⅝	4½	1	1 1/16	1	1

The central position of the reverse lever is back of the center of the quadrant, because of the extension of the top of the link for the long cut-off at starting. This is the reason why the 14th notch in backward motion has a different cut-off from the same notch in the forward motion as shown in this table. The numbering of the notches begins at the end of the quadrant in each case. The 13th notch is the usual running position in forward motion, giving a perfectly equalized cut-off at 6⅜ ins. The free and large steam passages and the 1½ in. lap were used to secure good steam admission at the short cut-offs. Compression was reduced to a point which is just sufficient to overcome the inertia of the reciprocating parts at the end of the stroke.

Engine Truck.

Bar truck frames could not be used on account of the unusual depth of the engine frames at the cylinders and the form shown in Fig. 26 was adopted. A large center casting is bolted between plate side frames with ends enlarged to receive the bolts from the journal box pedestals. The frames are 27 ins. apart to keep them out of the way and the box pedestals are made in the form of brackets extending out from the side frames. The equalizers are outside of the frames and their

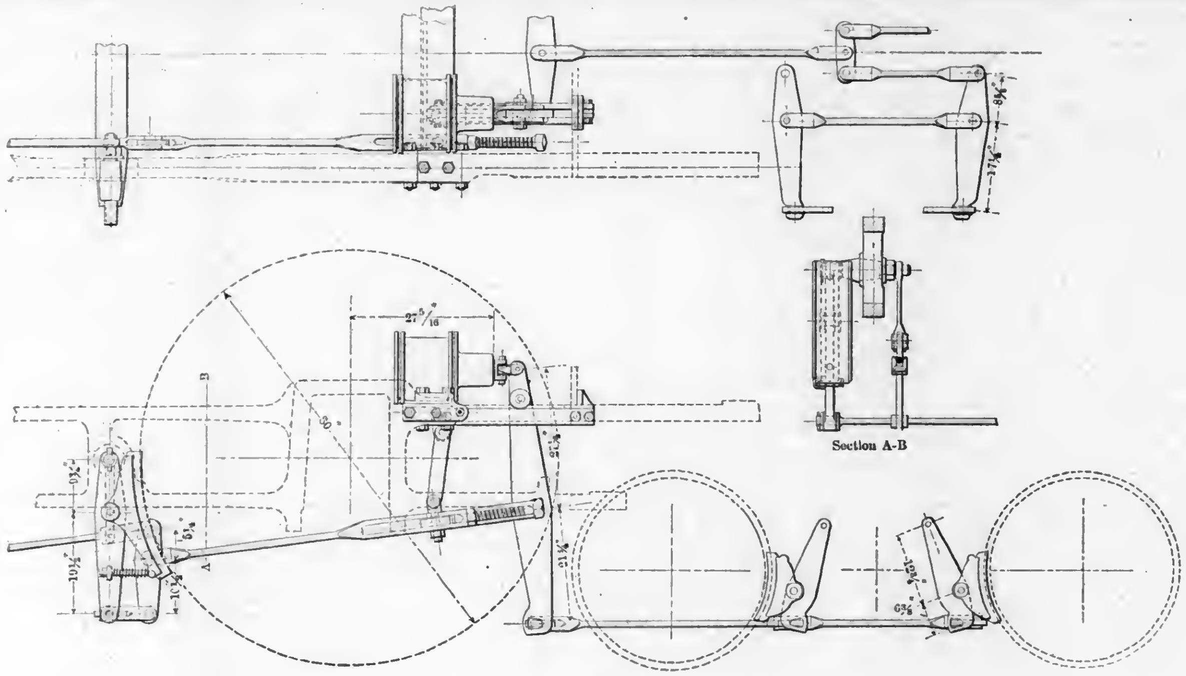


Fig. 27

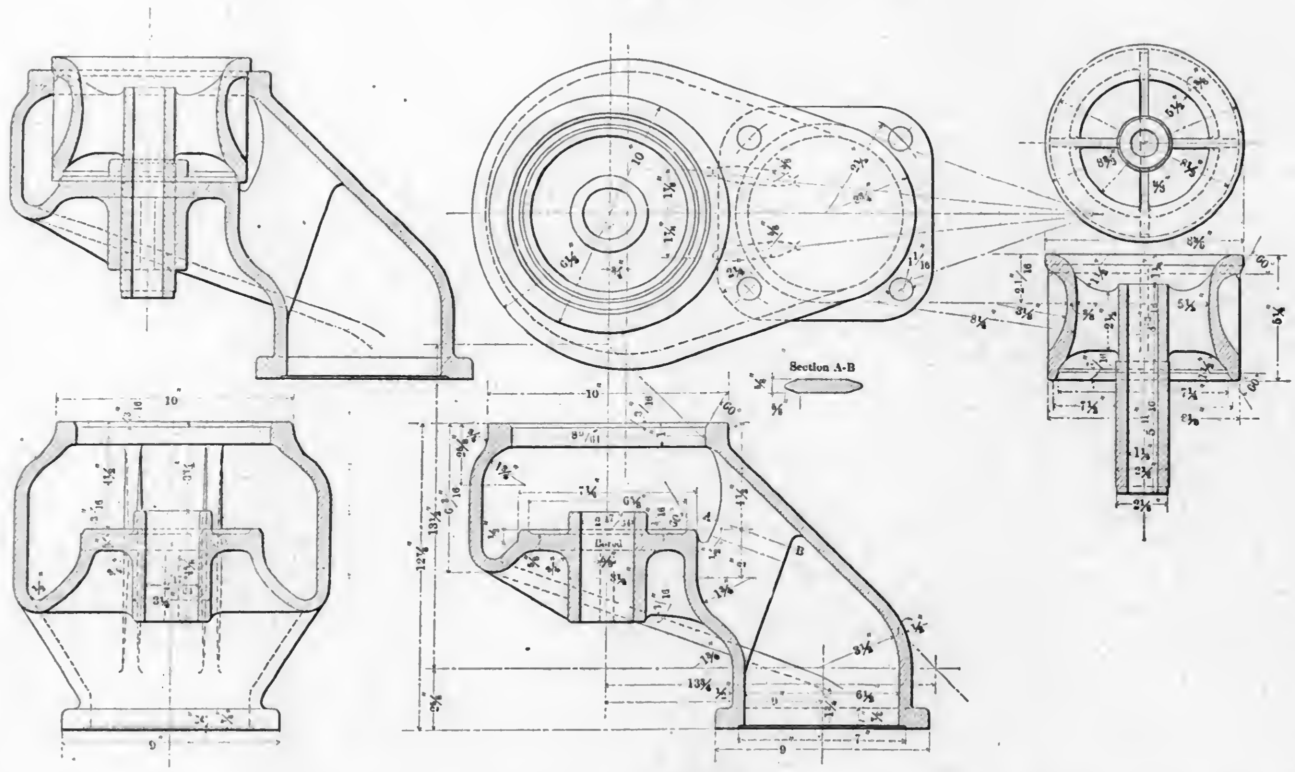


Fig. 28

ends are brought together to form ball and socket bearings on the boxes. The load is applied from the center plate to the equalizer springs by means of very strong brackets bolted to the outside faces of the side frames, the springs being placed between the bars of the equalizers. These brackets carry smaller brackets for the brake hangers. The ends of the truck frames are braced by combined tension and compression stays. The center casting is of iron and the brackets for the springs and pedestals are of cast steel. The center pin is formed in a steel casting bolted to the top of the center casting. The weight is received through liners held in a pocket in the center casting, which furnish an adjustment of the height of the front end of the engine to compensate for wear. While the load is received at the center of the wheel base of the truck and evenly distributed to the wheels, the pivot about which it turns is 9½ ins. back of the real center. As explained last month, this is done to increase the leverage of the leading truck wheels in guiding the engine and to reduce the lateral impact and the consequent wear of the flanges of the leading wheels. The diameter of the truck wheel is 36 ins.

Other Details.

Brakes.—Both the driver and truck brakes are operated by the same cylinders, one on each side of the engine, located in front of the forward driving axle. The driver brake shoes are back of the wheels and the truck shoes between the wheels. The cylinder levers are carried by rollers as shown in Fig. 27. These are connected across the engine by a horizontal equalizer, their lower ends connect with the truck floating lever, which is located with reference to the center of rotation of

the truck. This is believed to be the first time such a combination of truck and driver brakes has been used. The brake cylinders rest on a stiffening frame brace and the rollers and horizontal tracks serve to give a nearly rectilinear motion to the piston rod. There is a cross equalizer under the cylinders to permit of adjusting for the wear of the shoes on each side independently. The brake shoe center pins are above the centers of the shoes. When the brakes are "off" the spring adjustment between the stud on the lever and the eye on the shoe prevents the wear of the adjusting devices from causing rattling.

Throttle.—In order to avoid the leakage of built-up dry pipes, they were made of cast iron. The back end has a straight joint only slightly larger than the pipe. This was done for easy removal of the dry pipe through the tube sheet. The stand pipe has a right angle bend at the bottom to meet the dry pipe. This construction saves one joint and gives a smooth passage for the steam. A strong joint is made by means of claw hooks. Steam is taken from the top of the dome only, where it is driest. This is accomplished by making the throttle itself hollow and by closing the usual opening in the lower part of the bonnet. The form of the throttle and the direct passage for the steam into the dry pipe is shown in Fig. 28. During the first part of the motion of the throttle lever the leverage of the bell crank is very much greater than during the latter part, the well-known arrangement adopted by this road several years ago being used in a form modified to suit the conditions in this engine. This is a most excellent throttle design which has a distinct advantage in the shallow valve. Its height is but 5¼ ins., about half the usual amount.

Combined Sand Box and Dome.—A saddle-shaped, cast-iron sand box is combined with the steam dome in an elongated casing. The casing has a machine joint at the cover over the sand box, made to allow leaking steam to escape and yet prevent rain from entering. This reduces the number of obstructions on the boiler.

Piston and Valve Rod Packing.—A serious defect in many forms of rod packing is the failure to provide for sufficient lateral motion. The form now used on the Pennsylvania takes care of a total motion of 7/16 in. The packing is so made that it may be removed over the enlarged end of the rod. It is the most valuable improvement in metallic packing that we have seen.

Cab Fittings.—With the small space left in the cab at the sides of the large boiler, the cab fittings required most careful arrangement and this part of the work was done with characteristic thoroughness, and the result is surprising in the convenience with which the engine is operated. The injectors, which are "Sellers" No. 11½, Class N, are on the sides of the boiler and both are operated from the right-hand side. The throttle rod rotates and enters a stuffing box at the end of the 3½ in. pipe which supplies steam to the air pump, injectors and lubricators. In an angle of the end of this pipe the throttle motion is changed from rotating to reciprocating and the rod operates the valve by pushing. The air pump is on the left-hand side and is started by a rod within easy reach of the engineer. A Chapman valve, worked by a hand wheel, controls the steam to the cab fittings. The whole arrangement of piping is such as to keep them almost entirely out of sight. Cab fittings are generally considered as minor and unimportant details, but in this case they have received as careful consideration as any part of the engine. The result is a remarkably convenient arrangement for a cab with a wide firebox. Means of communication between the engineman in the cab and the fireman on the foot plate is provided for by the use of a speaking tube fitted with the usual whistle mouthpiece. This is continually used by the fireman by means of a conventional code to check the engineman's interpretation of signals.

Tender.—The tender is a unique feature of the engine and is described elsewhere in this issue by Mr. Wm. Forsyth.

Conclusion.

This is a well-designed engine, which has been remarkably successful in fast running. It has shown the unquestionable advantage of large grate areas in capacity and economy. It has also shown the importance of large and direct steam passages in which there is no restriction of area at and beyond the point where the steam divides to pass to the cylinders. The details are interesting and they impress one who examines them carefully with the possibilities of improving common practice by the application of principles which render accurate fitting possible and convenient. The greatest influence of this engine on future designs will probable lie in the direction of encouraging the construction of wider fireboxes, which not only give great boiler power, but permit of the use of cheap grades of fuel. If it were not for the separation of the engineer and fireman, the class would doubtless become a generally used standard on this road, but the objections to the separation are so great that the principal advantages of this class will be sought in a design modified to make it possible to bring the men together.

We do not know of a more worthy example of American locomotive practice and one containing so many evidences of thoughtful skill in design and thoroughly good workmanship in construction.

The general opinion of the tests made by the Master Mechanics' Association on exhaust arrangements, in 1896, is that they represent the most complete and altogether admirable work ever brought before that organization. It is now clear, however, that something more is needed upon this subject. Important suggestions with regard to the relation between petticoat pipes, deflector plates and exhaust pipes are made on another page of this issue by Mr. H. H. Vaughan, who is a close observer and careful student of the locomotive. His discussion of the arrangements of front-end appliances confirms a wide-spread opinion that the investigation of the "front end" has only begun. Mr. Vaughan lays stress upon the endorsement of the petticoat pipe by the committee, and indicates the advisability of submitting it to a series of tests, which should include experiments upon low nozzles and petticoat pipes, without combining them with the deflector plate. We believe that it is possible to equalize the draft through the tubes by an adjustment of the exhaust and petticoat pipes and omitting the deflector. If so, its effect as a retarder of the draft would be eliminated. But in addition to the arguments of Mr. Vaughan for further investigation is the fact that the length of stacks, which is influenced by the increased size of boilers, has a bearing on the question, the effect of which is seen in the extension of the stack down into the smokebox in a number of engines having large boilers. This, and the well-known intermittent action of the exhaust of two-cylinder compounds when running at slow speeds, should be added to the reasons for urging a reopening of the question, which, because of its bearing upon the economical operation of locomotives, is clearly important enough to warrant attention by the committee on subjects to be presented to the Master Mechanics' Association for report next year.

One hundred and eight patterns of car brasses make quite a formidable array. It is a silent commentary upon the meaning of the "M. C. B. standard," when such a lot of miscellaneous and grotesque metal shapes must be carried in stock on a single railroad to meet the combined requirements of home and foreign cars. Upon investigating a reason for carrying one of these patterns, we found that a certain prominent road is responsible for putting out brasses and wedges bearing the symbol "M. C. B.," of which the wedges are too narrow to work in standard M. C. B. journal boxes without allowing the brass to tilt over on its side and with side lips so deep that the lugs bear upon the lugs of the brass and prevent the top of the brass from touching the bottom of the body of the wedge. The brass will not work with an M. C. B. wedge and the wedge will not work with an M. C. B. brass. In justice to the railroads the name of this road ought to be made public.

Fig. 1.—New Dynamometer Car—Chicago & Northwestern Ry.

Fig. 2.—Rear View of Recording Machine.

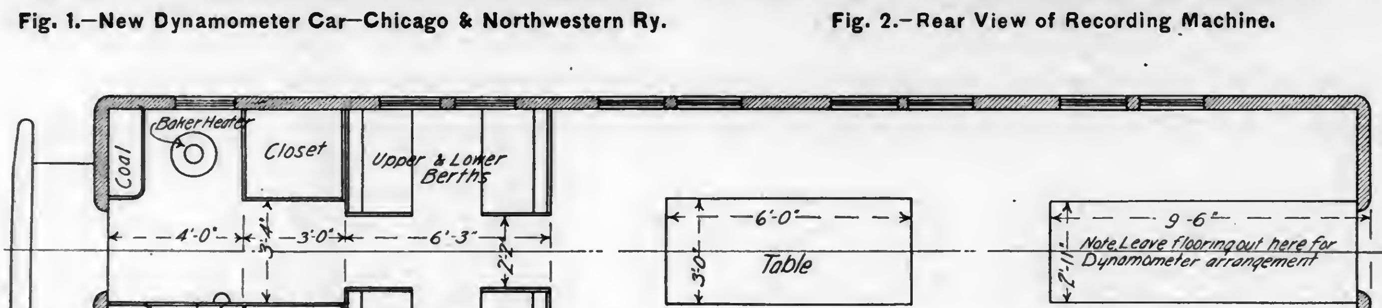


Fig. 4.—Floor Plan of Car.

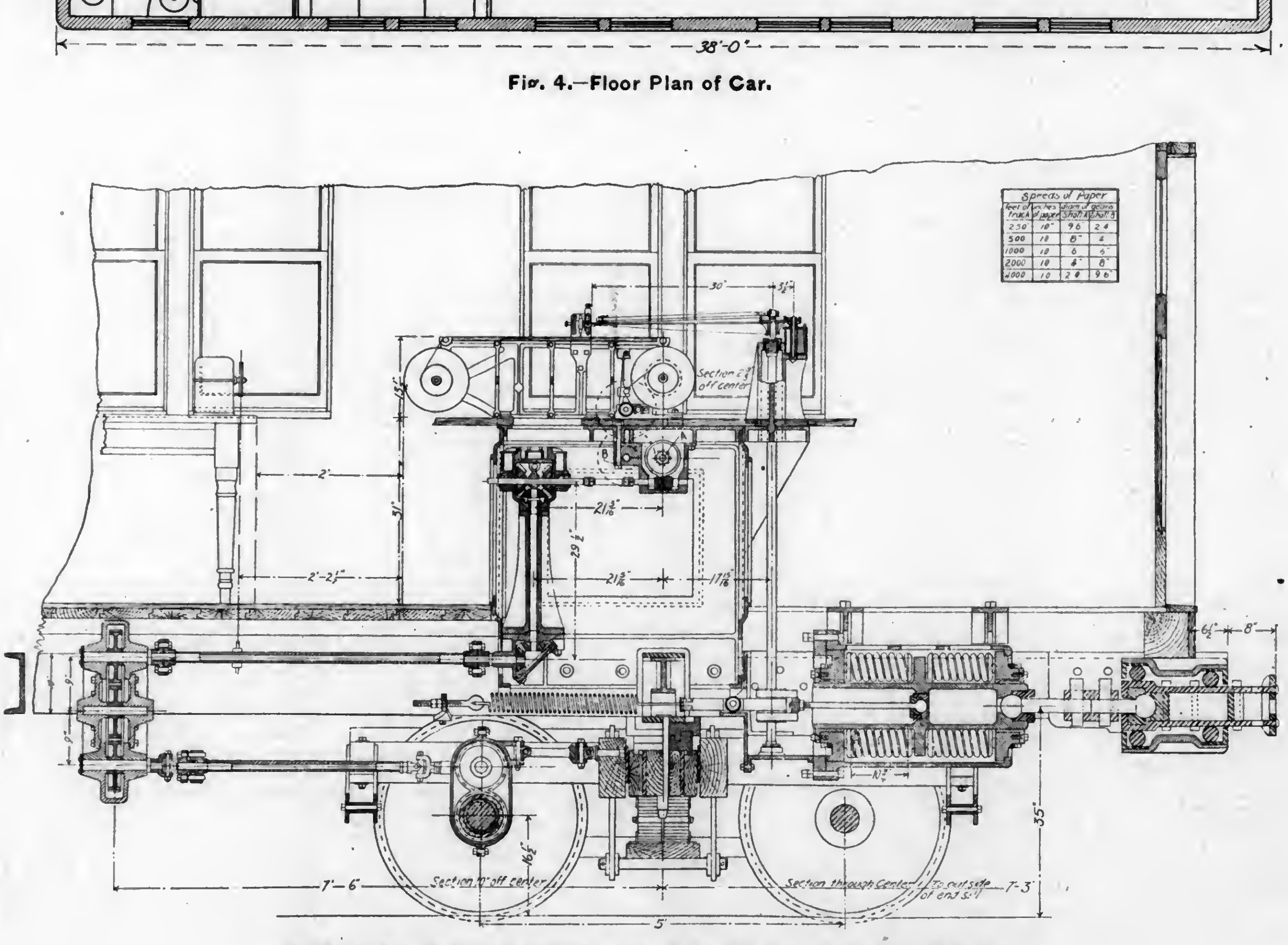


Fig. 5.—Draft Gear, Connection to Pencil and Train of Driving Gearing.

Fig. 3.—Front View of Recording Machine.

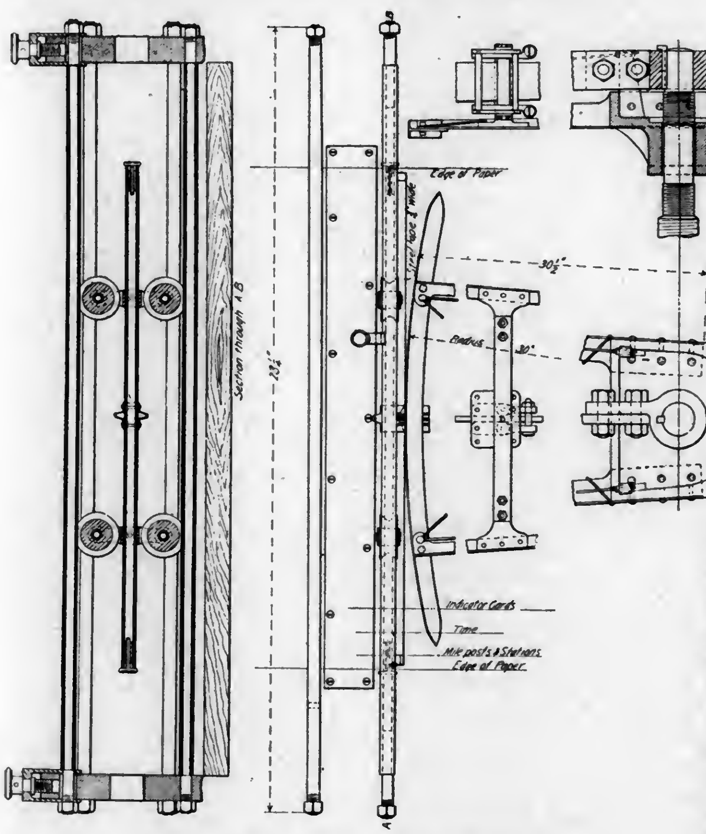
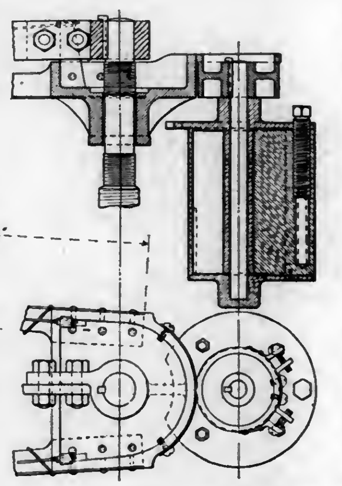



Fig. 6.—Dash Pot an Pencil Motion.

NEW DYNAMOMETER CAR.

Chicago & Northwestern Railway.

The new dynamometer car just completed by the Chicago & Northwestern Ry. has several novel features. The car is similar in construction to the standard cabooses of the road, except that the center sills are 10 in. channels, placed 21 in. apart and to these the draft gear is fastened. An ordinary M. C. B. coupler is attached to one end, while the other carries a specially designed link coupler attached to the follower by a ball joint. The illustrations present, in Fig. 1, an exterior view of the car; in Figs. 2 and 3, front and rear views of the recording machine; Fig. 4 is a floor plan; Figs. 5 and 6 show the draft springs, their connection with the machine, the machine itself, the pencil motion, including the dash pot, also the paper driving mechanism. Fig. 7 gives sections through the receiving and driving drums and the steel band connection between the drawbar and the vertical shaft to the pencil motion, as shown in Fig. 8.

There are 16 springs in all, arranged in two sets with a follower between them. The casing gives these springs an initial compression of about 4,000 lbs. each. The free height of the springs is 10¾ in. Their height under a load of 4,000 lbs. is 9.45 in. and under 6,500 lbs. 8.65 in. The coupler being attached to the central follower, will, with its movements, compress one spring still more and reduce the compression of the other correspondingly. The initial load is sufficient to be sure that the maximum drawbar pull will never entirely unload either spring. The object of this arrangement is to cause the errors of deflection of one set of springs to neutralize those of the other. It is well known that the deflections of spiral springs are different when ascending and descending when tested by gradually applied and gradually removed loads. This central follower takes care of the errors by causing one spring to be loaded while the opposite one is unloaded, the errors then counteract each other to an extent believed to give a degree of reliability which will render the machine fairly satisfactory and yet save the cost of an elaborate Emery dynamometer. The deflections of this arrangement are remarkably close to a straight line. The large number of springs were used in order to make the springs of small bars, which are more regular than large ones in their action. The capacity of the draft gear for recording is 50,000 lbs. This opposition of the springs also does away with lost motion and tends to produce a steadier pencil motion.

The motion of the recording draft gear is transmitted to the car through a vertical shaft connected to the drawbar by thin steel bands wrapped around a sheave at the lower end of the shaft, the slack being taken up by means of a light spring. A spring steel blade bears against vertical rollers secured to the pencil arm. The pencil arm swivels around the vertical shaft, but is loose upon it, and its vibration is controlled and steadied by a dash pot with rotary vanes, the arm being connected to the vanes of the dash pot by thin steel bands. The pencil is carried by a frame and rollers upon guides and it is connected to the arm by steel bands. The dash pot restricts the vibrations of the pencil arm to a small amount each side of the mean position, while the steel blade permits of the rotation of the shaft, which is connected with the drawbar, without restriction, and in service the blade is continually bending to the right and left while the pencil occupies a mean position with comparatively little vibration. The extent of the oscillations may be regulated by a screw in the by-pass of the dash pot.

The car has four wheel trucks and to one of the axles a universal telescopic motion mechanism is geared and five speeds are provided for the paper, viz., 25, 50, 100, 200 and 400 ft. of track per lineal inch of the paper travel. The scale changing gearing is similar to the screw-gears of a lathe. Five pens make the following records: A datum or zero line for the drawbar pull, the curve of the pull itself, an automatic time record marking ten-second intervals, a push button record for mile posts and stations and another push-button record from the engine to locate indicator diagrams and steam pressure. A Boyer speed recorder, gauges and clocks complete the apparatus. The comfort of the attendants was considered and sleeping accommodations for four men provided. The car has a table, a closet, vise and bench and is heated by a Baker heater.

The car is just finished and the preliminary tests indicate that it is likely to be satisfactory. The plan and details, including the opposition of the springs, were worked out by Mr. W. H. Marshall and Mr. F. M. Whyte, under the direction of Mr. Quayle. The construction was completed under Mr. G. R. Henderson

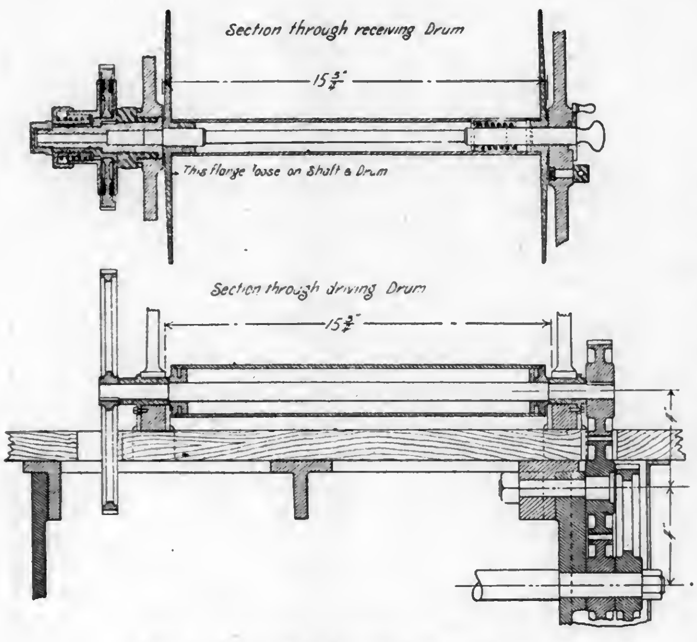


Fig. 7.—Sections Through Paper Drums.

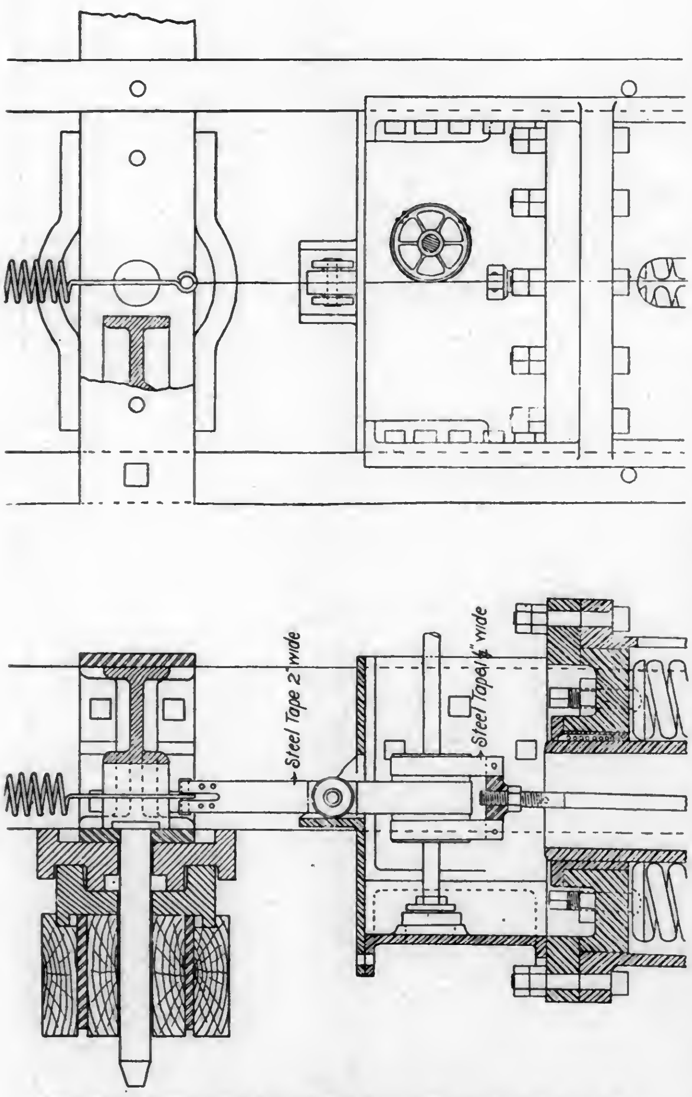


Fig. 8.—Motion Transmission from the Drawbar to the Recording Mechanism.

CONSIDERATION OF WEIGHT OF PARTS IN LOCOMOTIVE DESIGN.

By W. H. Marshall, Superintendent of Motive Power, Lake Shore & Michigan Southern Railroad.

Ten or twelve years ago but little attention was paid to the reduction of weight of details of locomotives. Cast and wrought iron entered largely into the construction of those parts and with no attempt to reduce their weight the amount available for the boiler was much too small. But large boilers were not so well appreciated then, and the writer recalls cases where a correct distribution of weight was accomplished by making the footplates nearly one foot thick and when this was not sufficient to keep down the weight on the front trucks to the amount desired the cab brackets were made three inches thick and the back running boards were made of cast-iron 1¾ inches thick. To-day such methods of effecting a correct distribution of weight are not considered for a moment, but the wheels are so placed with reference to the boiler as to give the correct distribution.

Notwithstanding that locomotives are much heavier to-day, there is a greater necessity than ever for getting the maximum power within the imposed limit of weight. In passenger service the high speeds and great weights of trains call for large horse-powers, and large horse-powers mean large boilers. Even in freight service where speeds are supposed to be slow the increased weight of trains and the reduction of ruling grades make the handling of freight economically a question of steaming capacity, so that the only correct rule for the size of the boilers of modern road engines is to get them as large as possible. In many cases the large boiler is vital to the success of the design, and then the scrutiny of details of machinery must be close. Before taking up these details it might be well to give some words to the boiler itself.

There may be quite a difference in the weight of boilers of various designs having the same steam-making capacity. The design of minimum weight will have its greatest diameter of shell at the back tube sheet, and the diameter at the back head will be as much less than this as is consistent with the removal of the firebox by cutting out the back head. For this reason the reduction cannot well exceed 7 or 8 inches. The diameter at the front tube sheet will be such that there will be no more room in that sheet for tubes than is available in the back sheet. In fact, the reduction at the front end can be carried still further if necessary, as the tubes can without detriment be spaced closer in the front tube sheet than in the back one. The first course of the shell can, without undue crowding of the front tube sheet, be made about 10 inches less than the diameter of the shell at the back tube sheet. The radial stay boiler is of course much lighter in weight than the crown bar type, and, all things considered, the writer believes it preferable to any other form.

Usually the length of the boiler is fixed within close limits by controlling features of the general design, but where there is a choice in length it is well to remember that heating surface can often be obtained for less weight by increasing the length of flues instead of increasing the diameter of the boiler and the number of flues. Some object to increasing the flues beyond 14 feet in length, but the writer sees no objections to lengths of 15 or even 16 feet, providing the number of flues is at least equal to current practice.

Some unnecessary weight is put into a boiler when the shell is not of the same factor of safety throughout. For instance, take the sheets of the first and third courses of a wagon top boiler. If with the same factor of safety one figures 21/32 and the other ¾ inch thick, they are usually ordered 11/16 and ¾ respectively. The one sheet may just as well be ordered in thirty-seconds and one hundred pounds or more saved. The outside firebox sheet of radial stay boilers is often made heavier than required. A difference of 1/16 inch in thickness of this sheet will mean about 500 lbs. if the box is 10 feet long.

As this sheet is thoroughly stayed there seems to be no good reason for making it more than ½ inch thick, or 9/16 inch at most, even for pressures of 200 lbs. No one wishes to take any chances in boiler construction, but within the limits of assumed safety there are opportunities to save weight in directions such as indicated above.

In taking up the details of machinery I would state at the outset that no attempt should be made to save a single pound by reducing the size of bearing surfaces or by deliberately using higher fiber stresses than are warranted in those parts that can be calculated. Crank pins and axles with fibre stresses of from 21,000 to 26,000 lbs. will certainly give trouble sooner or later and generally all too soon. Rod straps, bolts, keys, etc., that are a little too light for their work are a source of endless expense and anxiety, even if by careful inspection failures on the road are prevented. The greatest saving in weight is after all not obtainable in such questionable ways. It is in details not subject to calculation that the opportunities are found.

The use of pressed steel and cast steel of course permit considerable reduction in weight, but as far as cast-steel is concerned we have not gained as much as we might. Most of the cast-steel that has gone into locomotive construction has a tensile strength of between 60,000 and 65,000 lbs., an elongation of 15 to 18 per cent., and a reduction of area too small to talk about. The castings have not been annealed and the internal strains in the castings have not been eliminated sufficiently to warrant the designer in reducing the sections to what they should be for a supposedly high grade material. And yet with the steel now commonly used the reduction of sections has not been carried as far as practicable. In a recent case that came to the writer's attention the drawings of the driving wheels of a consolidation engine were revised and 1,600 lbs. taken out of the eight wheels. The hubs were reduced materially, also the spokes and rim, and the balances set out as close to the rim as possible. They were made as thick as due clearance of the rods would permit and their depth thereby reduced. This carried the centre of gravity farther from the centre and required less weight. When the foundry people saw the pattern they entered a protest at once, but were induced to give the pattern a trial, with the result that they made the wheels with less foundry loss than usual for that class of work. In such changes as these one has the satisfaction of knowing that he is not only saving weight to be used where it counts for much, but he is adding to the beauty of the engine and is also making the machinery more accessible, an advantage of no small importance when everything is as crowded as in the modern large engine.

The use of cast-steel foot plates, rock shafts, rock shaftboxes, driving boxes, equalizers, equalizer fulcrums, frame braces, etc., etc., are so common that they need no special mention. Cylinder heads, steam chests and steam chest covers are occasionally made in steel with a large saving in weight. Cylinder head and steam chest casings should of course be made of pressed steel, as also should boiler fronts and doors, dome and sandbox casings.

Frames are among the last parts that one cares to take any chances on, because of the trouble and expense of making repairs. And yet while going slow in the adoption of light sections, it is believed that the strains to which frames are subjected would be less complex and less metal would be required to withstand them if care is taken to support the frames to the boiler at every point where they receive a thrust from the equalizer rigging and springs. This does not necessarily add weight in the form of waist sheets, and expansion knees and pads; in fact, these last-named parts are usually heavier than necessary. One case is recalled where a pair of expansion knees on the sides of the firebox, as originally planned, weighed over 750 lbs., which weight was ultimately cut down by several hundred pounds.

It is not uncommon to find cast-iron cab brackets discarded for steel plates 5-16 or 3-8 in. thick, with angle iron edges. The saving in weight is about 350 lbs., and a further reduction is possible by making the plates ¼ in. thick, which is amply strong. Steel cabs or combinations of wood and steel are now in favor, but a substantial wooden cab good enough for anybody weighs much less. In a recent case of "whittling," a wooden cab was substituted for a part steel part wood cab of the same design and dimension, with a saving of 500 lbs.

On engines standing too high to permit the safety valves to be placed in the dome, it is not unusual to rivet a cast-iron turret on top of the boiler between the cab and dome for the reception of these valves. If this is dispensed with and the valves screwed directly into the boiler the weight saved may exceed 200 lbs. There is also a great difference in the weight of boiler coverings, and in a recent case 900 lbs. was saved by using a certain well-known covering in place of the one originally specified. The sandbox base, which is usually of cast iron can be made of pressed steel, with a saving of about 100 lbs. It is well known that the cast-iron steam pipes in the smokebox usually run much thicker than the drawings call for and if they are made to conform strictly to drawings, the reduction of weight is considerable.

Doubtless a still further scaling down of weights would result from the use of malleable iron steam pipes. Without resorting to the use of malleable iron, 300 lbs. was saved in the front end of a recent engine, though all of it did not come out of the steam pipes.

Grate side frames are usually heavy affairs and if so shaped that the ash pan hangs from them, they will weigh fully 700 lbs. per pair for a 10-ft. box. In a recent engine they were made of pressed steel and the ash pan hung from the frames with a net saving of between 300 and 400 lbs. Grate bar patterns can frequently be revised with a considerable saving of weight; in fact, out of the entire set of grate castings, including side frames from 500 to 800 lbs., can be taken. The ordinary fire door, with its heavy cast-iron frame can be replaced by a light pressed steel door hinged to the boiler head and without a frame, with a saving of 250 lbs.

Within the limits of this article it is not possible to mention every detail, and possibly those outlined above are sufficient to indicate where the savings can be effected and to what an extent they can be carried. Necessarily some practices already becoming common have been mentioned, and it is not the intention of the writer to claim as new all that has been outlined. In closing I would again call attention to the fact that the greatest savings in weight are to be found in those details in which little that is essential is jeopardized by the changes made.

Mr. Clarence M. Mendenhall, Superintendent of Motive Power of the Philadelphia, Washington & Baltimore, has resigned, to accept the position of Superintendent of Motive Power of the Chicago & Alton. Mr. Mendenhall began railway service in June, 1882, as an apprentice in the shops of the Pennsylvania Railroad. In April, 1899, he was appointed Assistant Road Foreman of Engines, on the New York division. This position he held until December, 1890, when he was made Assistant Master Mechanic of the Meadows shops, where he remained until 1894. when he became Assistant Engineer of Motive Power of the United Railroads of New Jersey division, and in June, 1895, he was made Superintendent of Motive Power of the Philadelphia, Wilmington & Baltimore.

Mr. Richard N. Durborow, heretofore Master Mechanic of the Pennsylvania, at Philadelphia, has been appointed Superintendent of Motive Power of the Philadelphia, Wilmington & Baltimore, to succeed Mr. C. M. Mendenhall.

John E. Battye, Master Mechanic of the Norfolk & Western, died at his home in Roanoke, Va., Thursday, May 17, after a very short illness. Mr. Battye was 51 years of age and was a native of Hunterfield, Yorkshire, England.

LOCOMOTIVE DESIGN.*

By F. J. Cole, Mechanical Engineer Rogers Locomotive Works.

Mean Effective Pressure and Horse-Power.

In estimating the tractive power of a locomotive it is necessary to know the maximum available mean effective pressures on the pistons at various speeds. It is evident that no exact ratio can exist between the speed and the mean effective pressure on all types, designs and builds of locomotives. For general use the best that can be done is to establish some average results which have been obtained from a large number of indicator cards, taken from different types of locomotives under various conditions of service. If a large number of indicator cards are selected which were taken at different speeds with a full or wide open throttle, when presumably the cut-off was adjusted so that the engine was doing its best work at that speed; and the positions plotted on a diagram whose vertical lines represent piston speed in feet per minute, and the horizontal lines percentages of boiler pressure (see Fig. 1), then a curved line can be drawn through these marks which will represent the average maximum mean effective pressure fôr different piston speeds under ordinary conditions.

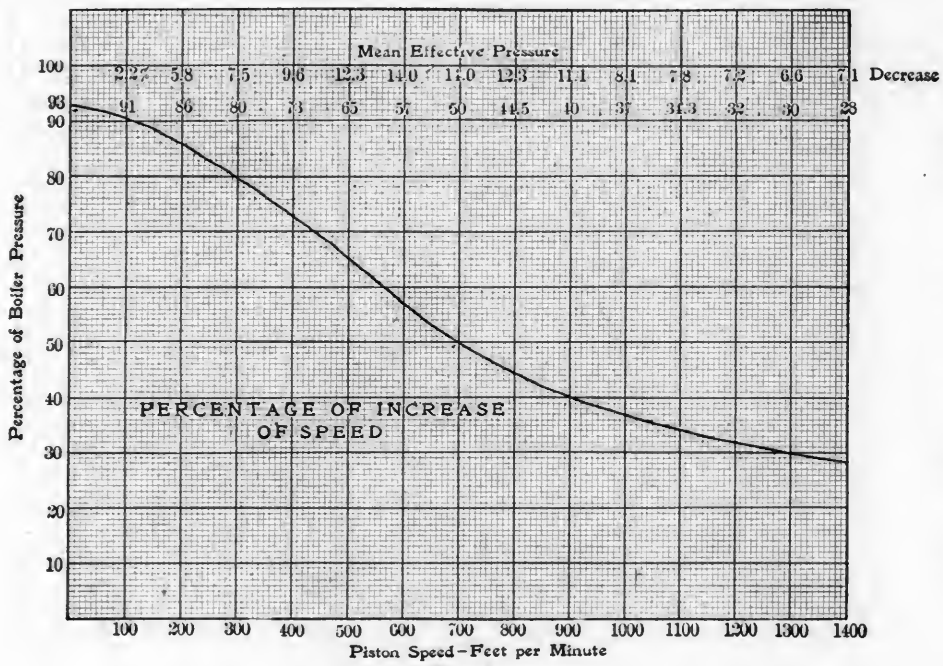


Fig. 1

Usually one of the limitations of the power of an engine at high speed is the inability of the boiler to supply steam in sufficient quantities at the point of cut-off which will produce the best results at that speed. If the boiler is inadequate, the power of the engine will necessarily be reduced in proportion to its shortcomings. Again, the supply of steam may be ample, but the means employed for its distribution may be so defective that the mean effective pressure is much lower than could be obtained with the most approved appliances. This may be caused either by insufficient port opening during admission, which "wiredraws" tne steam to such an extent that the pressure is reduced unnecessarily before the steam port is closed and before expansion takes place, or by the exhaust not taking place with sufficient freedom, causing a greater amount of back pressure than is absolutely necessary.

At starting, and at very slow speeds, with the valves in full stroke, it is possible to obtain a mean effective pressure within a few pounds of the boiler pressure. The back pressure under these conditions does not amount to much, as the movement of the piston is so slow that the steam has ample time to escape at its natural velocity without being assisted or crowded by the piston. As the speed increases, supposing the cut-off to be the same, the back pressure becomes a prominent factor in reducing the useful effect of the steam. Fig. 2 shows this very clearly, the first, or outer, diagram being taken at the moment of starting with a heavy train. Those superimposed were taken at the next moment when the tractive power exceeds the adhesion, causing the drivers to slip and revolve rapidly. The cut-off and the position of the throttle valve remain the same for the first two or three revolutions, but the mean effective pressure is decreased enormously by the increase of back pressure caused by the volume of steam being too great for the exhaust ports to release at a low pressure with a high piston speed.

For every locomotive there is some point of cut-off suitable to a given speed, at which point the engine will develop its greatest power. As the speed increases the reverse lever must be moved nearer to the center to decrease the length of the cut-off and prolong the expansion, so that at the time of release the pressure will be sufficiently reduced to allow the exhaust to take place without undue back pressure and to utilize as much as possible in an economical manner the expansive force of the steam.

The maximum mean effective pressure then decreases as the piston speed increases, following some fixed general law, but varying somewhat in different engines according to the capacity of the boiler, size of the pipes, kind of valve gear, etc. Fig. 1 shows a curve constructed from a very large number of indicator diagrams taken from different classes and builds of engines. It may be accepted as representing about the best maximum mean effective pressure obtainable under the usual conditions from single expansion locomotives. The range of pressures is from 93 per cent. at starting, and 80 per cent. at 300 feet, to 28 per cent. at 1,400 feet of piston speed per minute. To use the diagram, multiply the boiler pressure by the percentage appropriate to the piston speed; the quotient is the mean effective pressure. Table 2 is made in this way for boiler pressures varying by 10 pounds from 160 to 250 pounds per square inch.

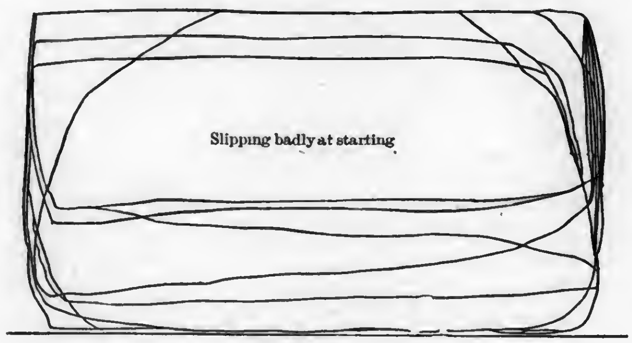


Fig. 2

The piston speed should not exceed 1,400 feet per minute under ordinary conditions. For economy the maximum speed is about 1,100 feet.

*For previous article see page 97.

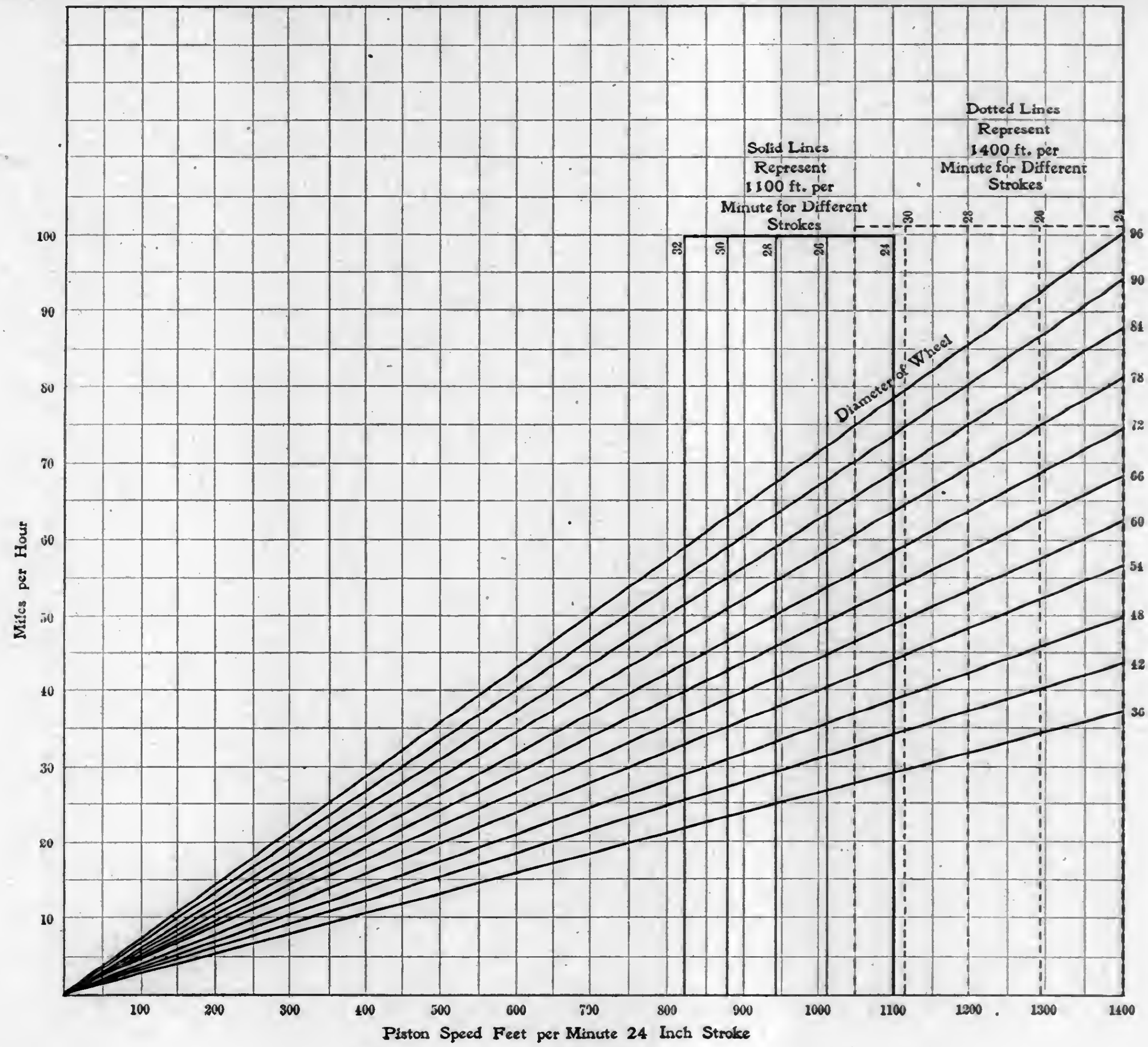


Fig. 3

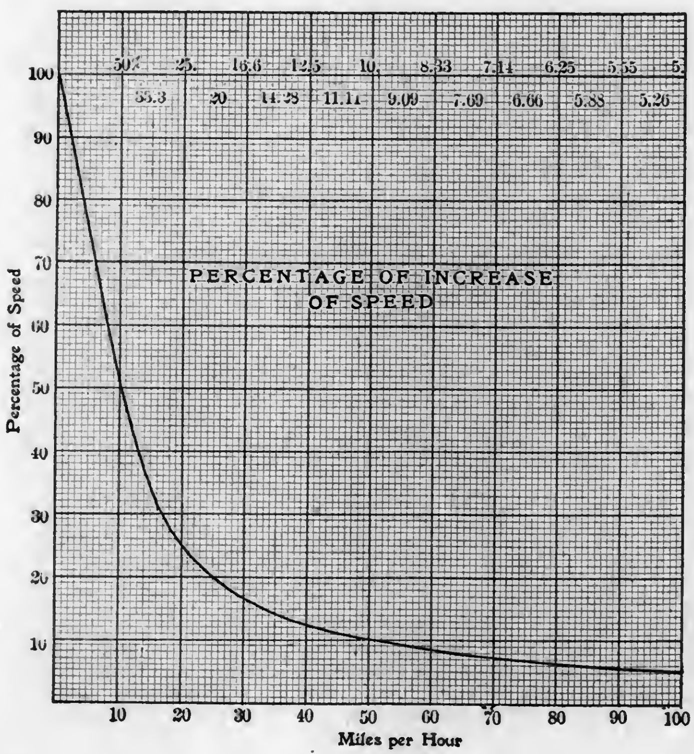


Fig. 4

TABLE NO. 2.
Mean Effective Pressure.

Boiler pressure.	Piston speed feet per minute.													
	100	200	300	400	500	600	700	800	900	1,000	1,100	1,200	1,300	1,400
100	91	86	80	73	65	57	50	44.5	40	37	34.3	32	30	28
160	146	138	128	117	104	91	80	71	64	59	55	51	48	45
170	155	146	136	124	110	97	85	76	68	63	58	54	51	48
180	164	155	144	131	117	103	90	80	72	67	62	58	54	50
190	173	163	152	139	1:3	108	95	84	76	70	65	61	57	53
200	182	172	160	146	130	114	100	89	80	74	69	64	60	56
210	191	181	168	153	137	120	105	93	84	78	72	67	63	59
220	200	189	176	161	143	126	110	98	88	81	75	70	66	62
230	209	198	184	168	150	131	115	102	92	85	79	74	69	64
240	218	206	192	175	156	137	220	107	96	89	81	77	72	67
250	227	215	200	183	162	142	225	111	100	92	86	80	75	70

The effect of long pipes in erroneously increasing the size of indicator cards at high speeds is clearly shown by Professor Goss, of Purdue University, in a paper before the American Society of Mechanical Engineers, May, 1896, and the Western Railway Club Proceedings of March, 1894. A number of cards taken at high speeds can be shown in which the mean effective pressure is higher at 1,200 to 1,300 feet per minute than those given in Fig. 1, but as the inaccuracy of the results obtained when the indicator is connected by long pipes seems to be proved, it is well to be cautious about accepting the higher figures.

The diagram shown in Fig. 3 is arranged to give prominence to these two facts. By its use the proper diameter of driving wheel for strokes varying from 24 to 32 inches can be obtained at a glance. A 24-inch stroke is used as the base of the

TABLE NO. 1.

Piston Speed in Feet Per Minute for 24-Inch Stroke.

Miles per hour.		5.		10.		15.		20.		25.		30.	
Dia. of drivers.	Rev. per mile.	Rev.	Piston speed.	Rev.	Piston speed.	Rev.	Piston speed.	Rev.	Piston speed.	Rev.	Piston speed.	Rev.	Piston speed.
36	560.2	47	187	93	373	140	560	186	746	233	933	280	1120
37	545.2	45	182	91	363	136	545	181	726	227	908	272	1090
38	530.6	44	177	88	354	132	531	176	707	221	884	265	1061
39	517.2	43	172	86	345	129	517	172	689	215	862	259	1034
40	504.0	42	168	84	336	126	504	168	672	210	840	252	1008
41	491.1	41	164	82	327	123	491	163	654	204	818	245	982
42	480.3	40	160	80	320	120	480	160	640	200	800	240	961
43	468.9	39	156	78	313	117	469	156	625	195	781	234	938
44	458.4	38	153	76	306	114	458	152	611	191	764	229	917
45	448.0	37	149	75	299	112	448	149	597	186	746	224	896
46	438.4	36	146	73	292	109	438	146	584	182	730	219	876
47	428.9	35.7	143	71	286	107	429	142	571	178	714	214	858
48	420.1	35	140	70	280	105	420	140	560	175	700	210	840
49	411.6	34	137	69	274	103	412	137	548	171	686	206	823
50	403.3	33.6	134	67	269	101	403	134	537	168	672	202	806
51	395 5	32.9	132	66	264	99	395	131	527	163	659	198	791
52	387.7	32.3	129	65	258	97	388	129	516	161	646	194	775
53	380.5	31.7	127	63	254	95	380	126	507	158	634	190	761
54	373.5	31.1	124	62	249	93	373	124	498	155	622	187	747
55	366.6	30.5	122	61	244	91	367	122	488	153	611	183	732
56	360.2	30	120	60	240	90	360	120	480	150	600	180	720
57	353.8	29	118	59	236	88	354	117	471	147	589	187	707
58	347.7	28.9	116	58	232	87	348	115	463	145	579	174	695
59	341.7	28.4	114	57	228	85	342	113	455	142	569	171	683
60	336.1	28.0	112	56	224	84	336	112	448	140	560	168	672
61	330.6	27.5	110	55	220	82	331	110	440	138	551	165	661
62	325.3	27.1	108	54	217	81	325	108	433	135	542	163	650
63	320.1	26.6	107	53	213	80	320	106	426	133	533	160	640
64	315.0	26.2	105	52	210	78	315	105	420	131	525	157	630
65	310.2	25.8	103	51.7	207	77	310	103	413	129	517	155	620
66	305.6	25.4	102	51	204	76	306	101	307	127	509	153	611
67	300.9	25.0	100	50	201	75	301	100	401	125	501	150	602
68	296.6	24.5	99	49	198	74	297	98	395	123	494	148	593
69	292.2	24.3	97	48.7	195	73	292	97	389	122	487	146	584
70	288.1	24.0	96	48	192	72	288	96	384	120	480	144	576
71	283.9	23.6	95	47	189	71	284	94	378	118	473	142	567
72	280.1	23.3	93	46.6	187	70	280	93	373	116	466	140	560
73	276.3	23.0	92	46	184	69	276	92	368	115	461	138	552
74	272.5	22.7	90.8	45	182	68	272	90	363	113	454	136	545
75	268.9	22.4	89.6	44.8	179	67	269	89	358	112	448	131	537
76	265.3	22.1	88.4	44	177	66	265	88	353	110	442	132	530
78	258 6	21.5	86	43	172	64	259	86	345	108	431	129	516
80	252.1	21.0	84	42	168	63	252	84	336	105	420	126	504
84	240.1	20.0	80	40	160	60	240	80	320	100	400	120	480
86	234.5	19.5	78	39	156	58	234	78	312	97	390	117	469
90	224.1	18.7	75	37	149	56	224	74	299	93	373	112	448
96	210.0	17.5	70	35	140	53	210	70	280	87	350	105	420

Miles per hour.	35.		40.		45.		50.		55.		60	
Dia. of drivers.	Rev.	Piston speed.	Rev.	Piston speed.	Rev.	Piston speed.	Rev.	Piston speed.	Rev.	Piston speed.	Rev.	Piston speed.
36	326	1307	373	1493	420	1681	466	1867	513	2054	560	2240
37	317	1272	363	1453	408	1635	454	1817	499	1999	545	2180
38	309	1238	354	1414	396	1592	442	1768	486	1945	531	2122
39	301	1207	345	1379	387	1552	431	1724	474	1896	517	2068
40	294	1176	336	1344	378	1512	420	1680	462	1848	504	2016
41	286	1146	327	1299	369	1473	409	1637	450	1801	491	1964
42	280	1120	320	1280	360	1441	400	1601	440	1761	480	1922
43	273	1094	313	1250	351	1407	390	1563	429	1719	469	1876
44	267	1069	306	1222	342	1375	382	1528	420	1681	458	1834
45	261	1045	299	1194	336	1344	373	1493	410	1642	448	1792
46	255	1022	292	1168	327	1315	365	1461	402	1607	438	1752
47	250	1000	286	1143	321	1287	357	1429	393	1572	429	1715
48	245	980	280	1120	315	1260	350	1400	385	1540	420	1680
49	240	960	274	1097	309	1236	343	1372	377	1509	412	1646
50	235	941	269	1075	303	1209	336	1344	370	1478	403	1612
51	230	922	263	1054	297	1185	329	1318	362	1450	395	1582
52	226	904	258	1033	291	1164	323	1292	355	1421	388	1550
53	222	887	251	1014	285	1140	317	1268	349	1395	380	1522
54	217	871	249	996	279	1119	311	1245	342	1370	373	1494
55	213	855	244	977	273	1101	305	1222	336	1344	367	1464
56	210	840	240	960	270	1080	300	1200	330	1320	360	1441
57	206	825	236	943	264	1062	294	1179	323	1297	354	1415
58	202	811	232	927	260	1044	289	1159	318	1275	340	1391
59	199	797	228	911	256	1026	284	1139	312	1253	342	1367
60	196	784	224	896	252	1008	280	1120	308	1232	336	1344
61	193	771	220	881	248	993	275	1102	303	1212	331	1322
62	189	759	217	867	244	975	271	1084	298	1192	325	1301
63	186	747	213	853	240	960	266	1067	293	1174	320	1280
64	183	735	210	840	236	945	262	1050	288	1155	315	1260
65	181	724	207	827	232	930	258	1034	284	1137	310	1241
66	178	713	204	814	229	918	254	1018	279	1120	306	1222
67	175	702	201	802	225	903	250	1003	275	1103	301	1204
68	173	692	198	791	222	891	247	988	272	1087	297	1186
69	170	687	195	779	219	876	243	974	267	1071	292	1168
70	168	672	192	768	216	864	240	960	264	1056	288	1152
71	165	662	189	757	213	852	236	946	260	1041	284	1134
72	163	653	187	747	210	840	233	933	256	1026	280	1120
73	161	644	184	737	207	828	230	921	253	1013	276	1104
74	159	635	182	726	201	816	227	908	250	999	272	1090
75	157	627	179	717	201	807	224	896	246	986	269	1074
76	154	619	177	707	198	796	221	884	242	972	265	1060
78	151	603	172	689	194	776	215	852	237	948	259	1034
80	147	588	168	672	189	756	210	840	231	924	252	1008
84	140	560	160	640	180	720	200	800	220	880	240	960
86	136	547	156	625	175	703	195	781	215	859	234	938
90	130	523	149	598	168	672	187	747	206	822	224	896
96	122	490	140	560	157	630	175	700	193	770	210	840

Miles per hour.	65.		70.		75.		80.		85.		90.		95.		100.	
Dia. of drivers.	Rev.	Piston speed.	Rev.	Piston speed.	Rev.	Piston speed.	Rev.	Piston speed.	Rev.	Piston speed.	Rev.	Piston speed.	Rev.	Piston speed.	Rev.	Piston speed.
36	606	2427	653	2614												
37	590	2362	635	2544												
38	575	2299	619	2476												
39	560	2240	603	2414												
40	546	2184	588	2352												
41	532	2128	573	2292												
42	520	2082	560	2241												
43	508	2032	547	2188												
44	496	1987	535	2139	573	2292										
45	485	1941	522	2090	559	2239										
46	474	1898	511	2045	547	2191										
47	465	1858	500	2001	536	2144										
48	455	1820	490	1960	525	2100										
49	446	1783	480	1921	514	2058	548	2195								
50	437	1746	470	1882	504	2016	537	2150								
51	428	1714	461	1845	494	1977	527	2108								
52	420	1679	452	1809	481	1938	516	2066	548	2195						
53	412	1649	444	1775	476	1902	507	2029	539	2156						
54	404	1619	435	1743	466	1838	498	1992	529	2116						
55	397	1586	427	1711	458	1833	488	1955	519	2077						
56	390	1561	420	1680	450	1800	480	1921	510	2041						
57	383	1533	412	1651	441	1769	471	1886	500	2001						
58	377	1507	405	1623	431	1739	463	1854	492	1970						
59	370	1481	398	1595	426	1709	455	1822	483	1936	512	2050				
60	364	1456	392	1568	420	1680	448	1792	476	1904	504	2016	532	2128	560	2240
61	358	1432	386	1543	413	1653	440	1762	468	1872	496	1983	524	2093	551	2204
62	352	1409	379	1518	406	1626	433	1735	460	1843	488	1951	515	2059	542	2168
63	347	1387	373	1491	400	1601	426	1707	453	1814	480	1921	507	2028	533	2134
64	341	1365	367	1470	393	1575	420	1680	446	1785	472	1890	498	1995	525	2100
65	336	1344	362	1448	388	1551	413	1654	439	1757	465	1861	491	1964	517	2068
66	331	1324	356	1426	381	1528	407	1629	432	1731	458	1833	483	1935	509	2037
67	326	1304	351	1404	376	1504	401	1604	426	1704	451	1805	476	1905	501	2006
68	322	1285	346	1384	371	1483	395	1582	420	1681	445	1779	470	1878	494	1977
69	316	1265	341	1374	365	1471	389	1558	413	1655	438	1753	462	1850	487	1948
70	312	1248	336	1344	360	1440	384	1536	408	1632	432	1728	456	1824	480	1920
71	308	1229	331	1321	355	1419	378	1514	402	1609	426	1703	450	1798	473	1892
72	303	1213	327	1307	350	1400	373	1491	396	1587	420	1680	443	1773	466	1867
73	299	1196	323	1289	346	1381	368	1474	391	1566	415	1658	438	1750	461	1842
74	295	1181	319	1271	342	1362	363	1452	386	1543	408	1634	431	1725	454	1816
75	291	1161	314	1254	336	1344	358	1434	380	1524	403	1613	425	1703	448	1792
76	287	1148	308	1238	330	1326	353	1414	375	1502	397	1591	419	1679	442	1768
78	281	1120	302	1207	324	1293	345	1379	367	1465	388	1551	410	1637	431	1724
80	273	1092	294	1176	315	1260	336	1344	357	1428	378	1512	399	1596	420	1680
84	260	1040	280	1120	300	1200	320	1280	340	1360	360	1440	380	1520	400	1601
86	254	1016	273	1094	293	1172	312	1250	332	1328	351	1407	370	1485	390	1563
90	243	971	261	1046	280	1121	299	1195	318	1270	336	1315	355	1420	373	1494
96	228	910	245	980	263	1050	280	1120	298	1190	315	1260	333	1330	350	1400

This table is made for 24-inch stroke. To obtain piston speed for other lengths of stroke, multiply the figures in the table by:

.666 = 16 stroke	1.166 = 28 stroke
.750 = 18 "	1.250 = 30 "
.833 = 20 "	1.333 = 32 "
.911 = 22 "	1.417 = 34 "
1.000 = 24 "	1.500 = 36 "
1.083 = 26 "	

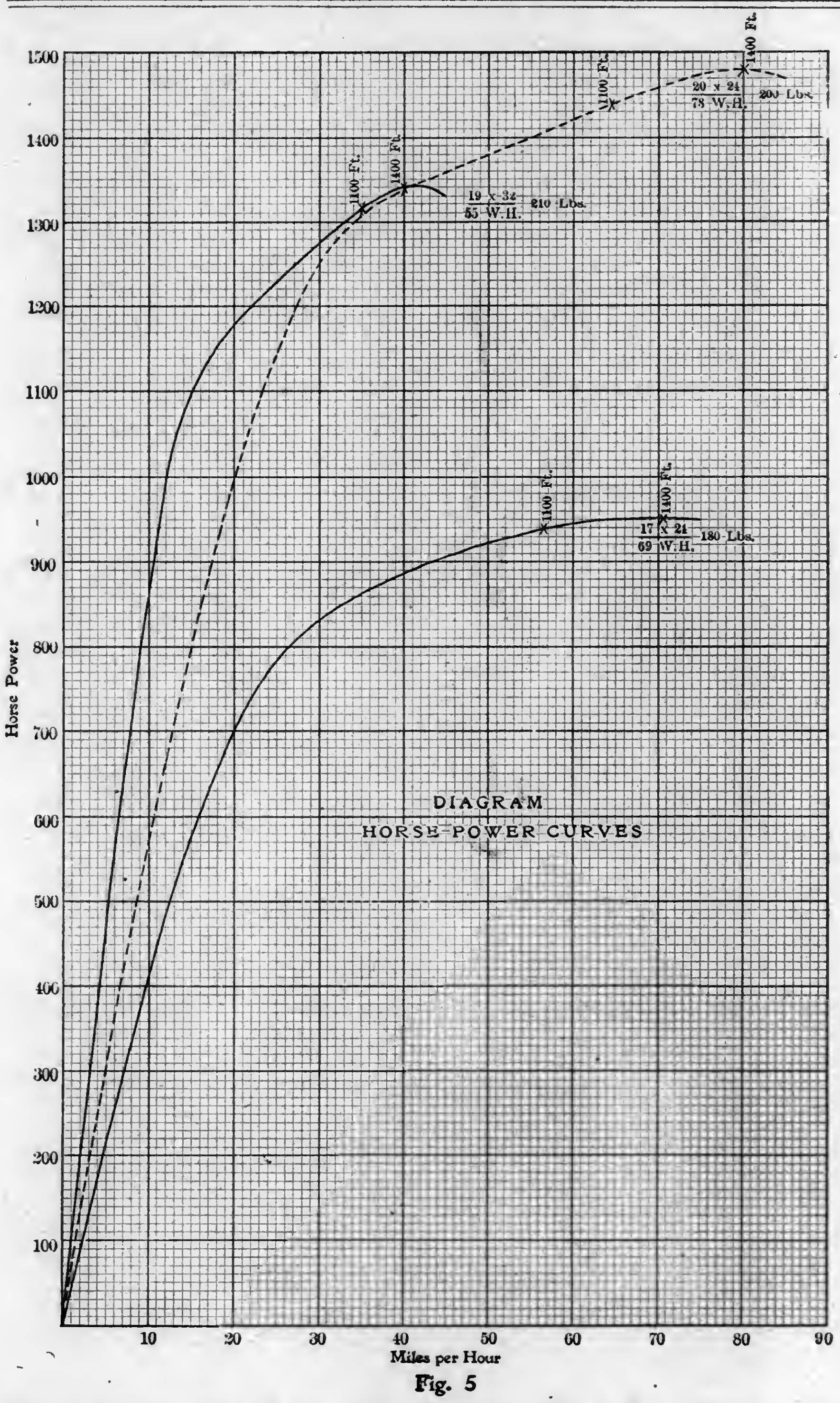


Fig. 5

diagram and the heavy vertical lines at 1,100 and 1,400 feet respectively show the limits of economy and speed for wheels varying by six inches from 36 to 96 inches in diameter. The vertical lines marked 26, 28, 30 and 32 represent piston speeds of 1,100 feet for each of the strokes mentioned. To use the diagram, follow the horizontal lines for any given speed in miles per hour to its intersection with either of the vertical lines marked 1,100 or 1,400 feet, the nearest diagonal line at this point represents the diameter of the driving wheel. Example: What is the least diameter of wheel with a stroke of 24 inches for a maximum speed of 69 miles per hour? Follow the horizontal line 69 along until it is over the vertical line marked 1,400. The diagonal line marked 66 also intersects at this point, so that a 66-inch wheel is the minimum diameter which should be used. The diagonal line marked 84 intersects the vertical line marked 1,100, so that a wheel of 84 inches would be more economical, other things being equal.

The horse-power of a locomotive is the tractive force in pounds multiplied by the speed in miles per hour divided by 375.

Let H = horse-power,
S = speed in miles per hour,
T = tractive force,

$$\text{Then } H = \frac{TS \times 5280}{33{,}000 \times 60} = \frac{TS}{375}.$$

If the horse-power of a locomotive is worked out for different speeds, a point will be found at which it ceases to increase, where the mean effective pressure decreases faster than the speed increases. The percentage of increase of speeds for increments of 5 miles per hour is shown in the diagram Fig. 4. Between 5 and 10 miles the increase is 50 per cent., between 10 and 15 miles it is 33.3 per cent., but between 70 and 75 miles only 6.66 per cent. The percentage of decrease of the mean effective pressure is shown in the diagram Fig. 1. Between 100 and 200 feet per minute the decrease is 5.8 per cent., between 500 to 600 feet per minute it is 14 per cent., and between 1,200 to 1,300 feet per minute it is 6.6 per cent.

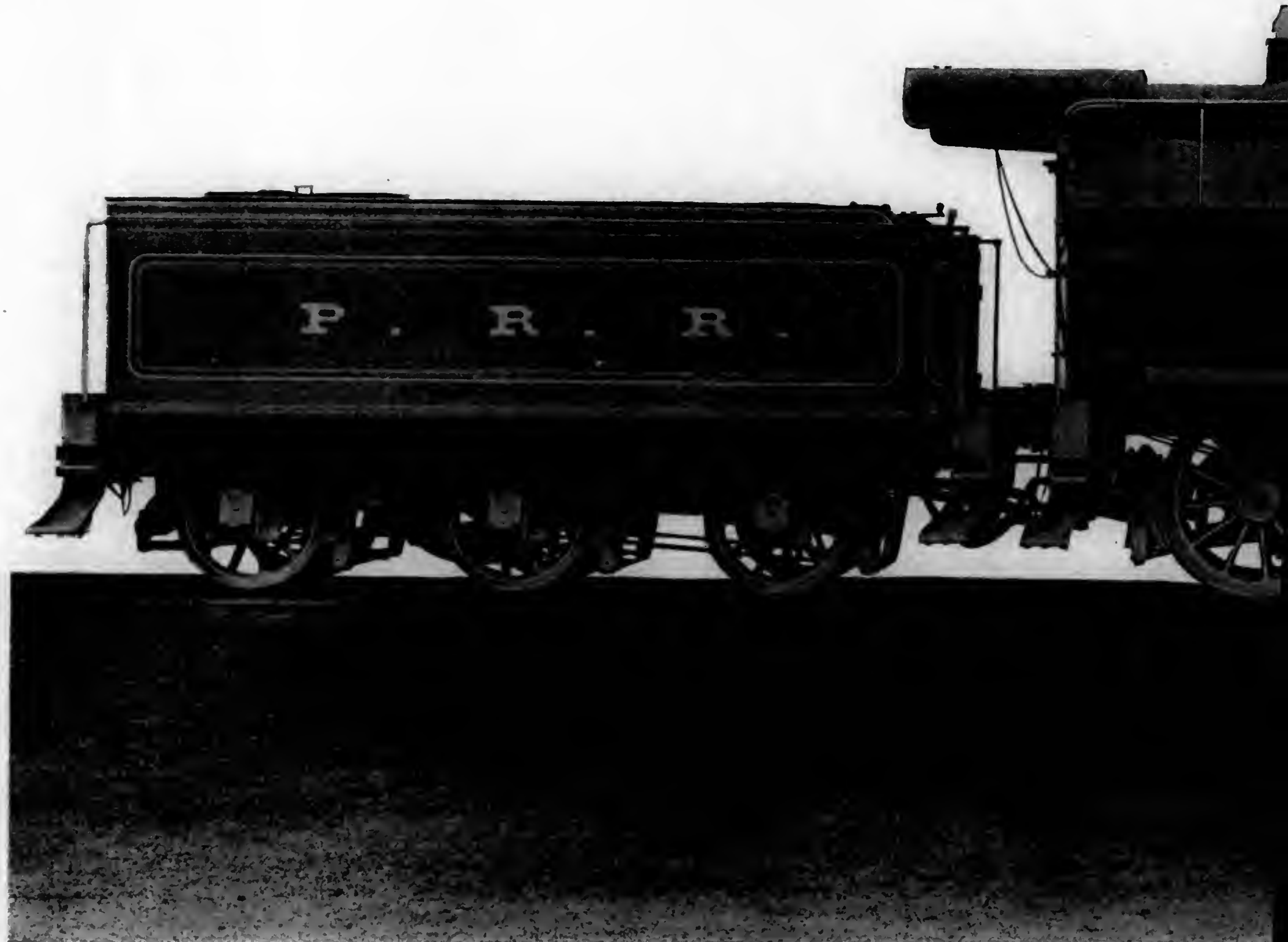
The diagram Fig. 5 shows the horse-power curves for 17 by 24, 19 by 32 and 20 by 24 inch locomotives with different diameters of wheels. The critical points at which the horse-power commences to decrease are at 70, 40 and 80 miles respectively, which represents about 1,400 feet per minute for each of these curves.

The ability of an engine to handle heavy trains at high speeds depends upon the horse-power which can be developed at the mean velocity required. While under exceptionally favorable circumstances very high speeds can often be made with engines running above their critical speeds, yet for ordinary conditions a large surplus of power must be provided to accelerate the speed rapidly in a comparatively short time. The proportions of an engine should be such that the required maximum speed may be made at a point in the horse-power curve, while the ratio of increase is still considerable and before the line approaches the horizontal where the increase of power ceases.

From the horse-power curve the pounds of steam required at different speeds, the dimensions of the boiler, size of grate, rate of combustion and heating surfaces can be readily estimated.

MORTENSON'S NUT LOCK.

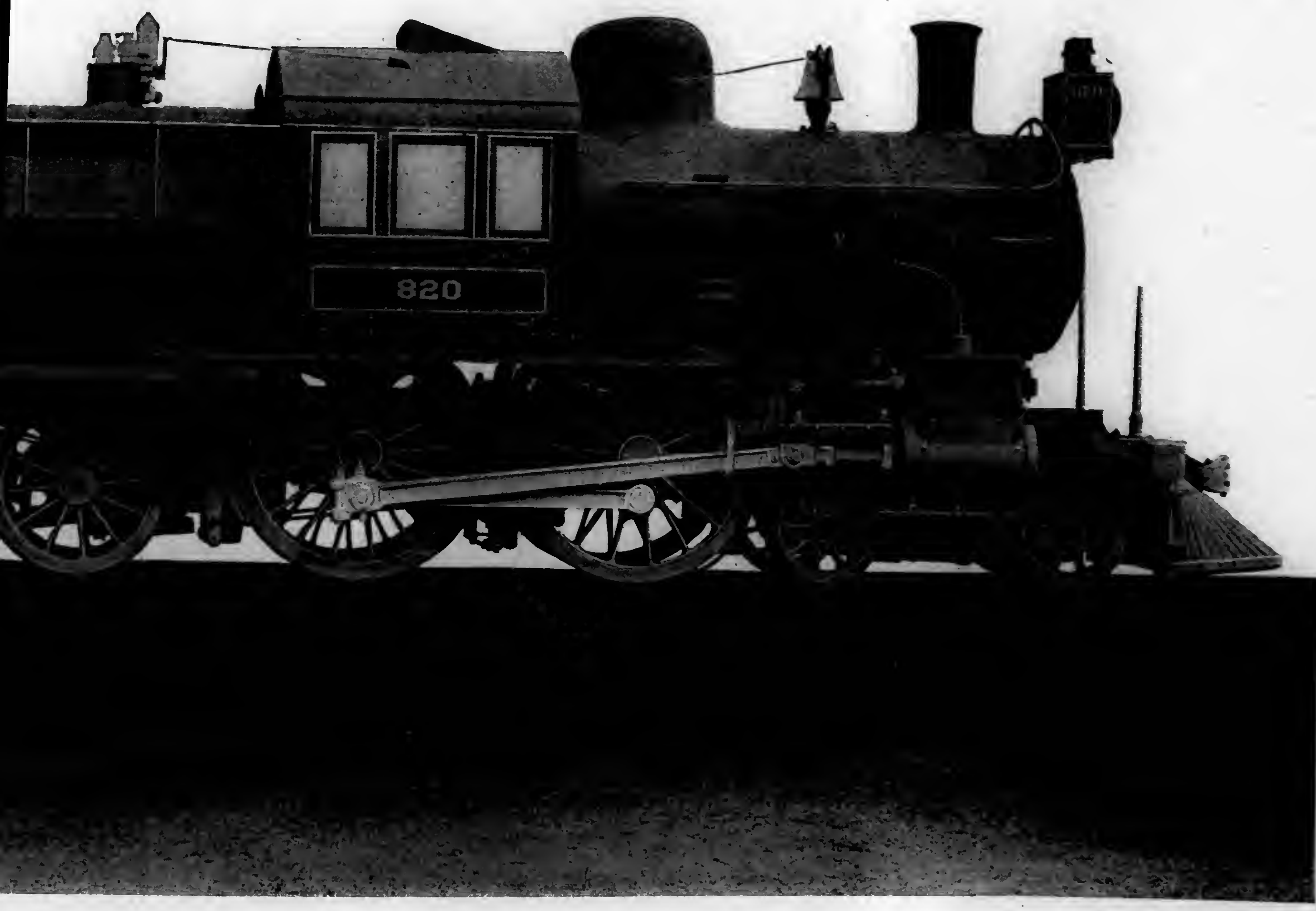
The Mortenson Lock Nut Company, 803 170th Street, New York, manufactures a very simple, inexpensive and efficient nut lock which has been used with excellent results for five years in car work on the Southern Pacific Railway. This lock does not require extra parts. It is easily applied and easily removed, but does not loosen in service. An ordinary nut is used and the four corners are slit by a saw cut near the bearing face and parallel to that face. After the nut is screwed home a cold chisel is driven into one of the saw slits which bends the lip into a groove provided in the washer, or, in the absence of a washer, in the metal against which the nut bears. This obviously makes a secure fastening. The cost is very little, if any, more than that of ordinary nuts without this feature.



ATLANTIC TYPE, FAST PASSENGER

CL

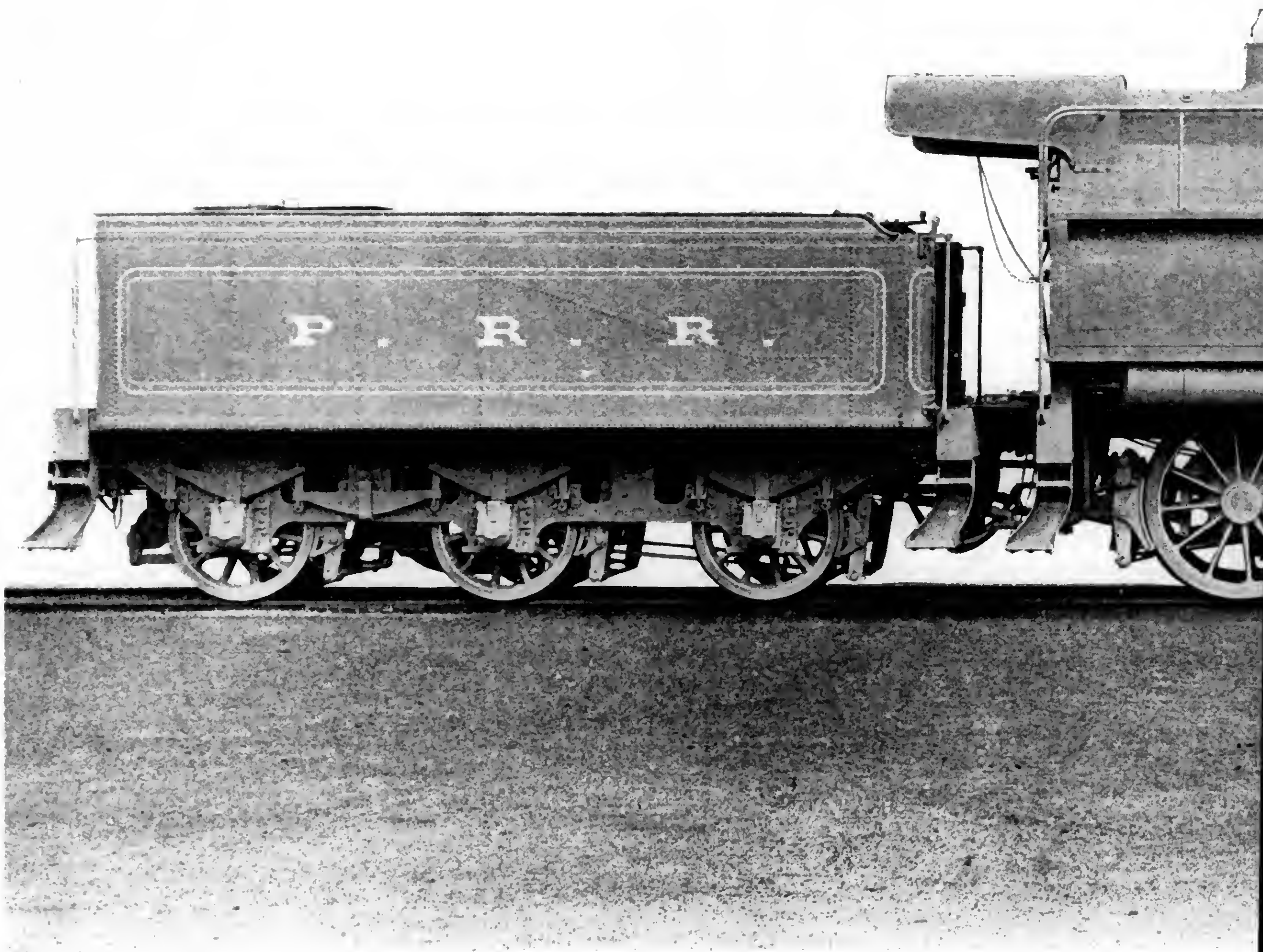
BUILT AT JUNIAT



GER LOCOMOTIVE, PENNSYLVANIA RAILROAD.

CLASS E 1.

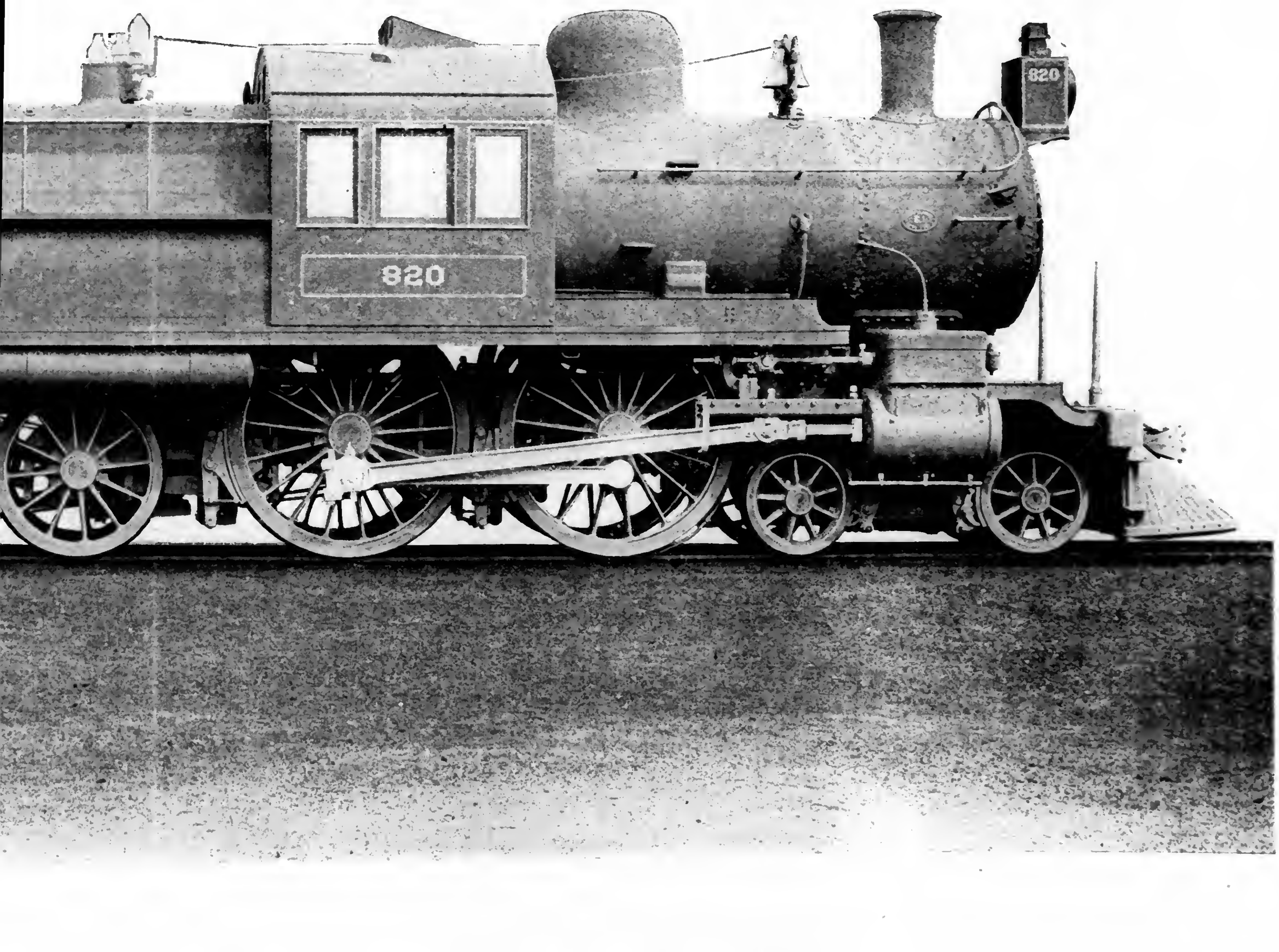
NIATA SHOPS, ALTOONA, PA.



ATLANTIC TYPE, FAST PASSENGER

CL

BUILT AT JUNIAT



GER LOCOMOTIVE, PENNSYLVANIA RAILROAD.

CLASS E 1.

NIATA SHOPS, ALTOONA, PA.

lustrated in the April number of the "American Engineer," and which has been christened the "Prairie" type.

It must be admitted that all of these forms of locomotives have been accepted with a good deal of hesitation by locomotive superintendents and master mechanics generally, which may in part be due to the fact that in a number of instances the feature which is the distinguishing merit of this form of design has been omitted—that is, the wide fireboxes—and in one or two other instances unfortunate deficiencies of design of such fireboxes resulted in their failure. In this evolutionary world every newcomer must adapt himself or itself to its environment. Many cases could be named of mechanical conceptions which failed utterly when they were first introduced, and which, after being adapted to their environments, became brilliant successes. Piston and balanced valves for locomotives, and cable railroads, are instances. The latter was tried twenty years ago on the first elevated railroad, built in New York, and failed utterly. Later on it was taken up in San Francisco and has been applied successfully on a number of roads in other cities, although since then it is being superseded by the electric system of overhead and underground trolley lines.

It may be that those who now condemn what might not inappropriately be called (because they are so heavy behind) the "kangaroo' species of locomotives, will have occasion later on to modify their opinions of them. That plan is the only one which permits of having a firebox of sufficient length, depth and breadth for engines of the sizes and weights which are now required. The firebox is the source of power, and if it is too small nothing else will compensate for the deficiency. It is therefore believed that the future development of the locomotive will embody the "kangaroo" feature; that is, that the fireboxes will be behind the driving wheels and will be made of a width considerably greater than the space between them, and of ample depth.

The influence of the demand for more powerful locomotives is shown in a recent design by the Baldwin Locomotive Works for the McCloud River R. R. This consists of two six-wheeled engines, coupled together "tail to tail," and with a fuel bin and a water tank on each. The object of this plan is to attain the advantages claimed for the double Fairlie engine, which was so urgently advocated thirty years ago. The difficulty with the plan shown will, it is thought, be the same as was encountered with the Fairlie engines. It was impossible to provide sufficient boiler, fuel and water capacity without overloading the driving wheels. If we take the case of a ten-wheel locomotive, we have, as in one of the single engines referred to, six driving wheels, the requisite boiler and machinery for which are carried on ten wheels, and the water and fuel on eight more. Now in the double locomotive for the McCloud River R. R. each machine must have boiler, machinery, water and fuel sufficient for six coupled driving wheels, the same as with a ten-wheel machine, and all of these must be carried on six wheels instead of on eighteen, as in the ten-wheel engine. For any continuous or fast service the six-wheeled engine must be deficient in some or all of these elements which are so essential for efficiency. The locomotive referred to is intended for working only a short distance so that it may have sufficient boiler water and fuel capacity for such service, but would not have for long runs.

Some years ago several locomotives of a similar design were built by Neilson in Glasgow, for an Indian railroad, but with the difference that there was a double-end tender placed between the two engines, and they were coupled to it. This gave ample capacity for water and fuel, and it would not appear to be an unsolvable problem to provide some device by which the two throttles and the reverse levers of both engines could be operated from either one. A fireman on each would, however, be required.

It would not be surprising if the demand for more powerful locomotives should revive the old scheme of double or twin locomotives which so many inventors have aimed to make practicable. With two "kangaroos" coupled in some way to an intermediate tender, it would be possible to more than double the power of any ten-wheel consolidation or decapod engines, because the twins might have sufficient grate area, and also, what is regarded as of great importance, ample combustion space.

LOCOMOTIVE TENDERS.

Several Examples of Improved Practice.

By William Forsyth.

We recently directed attention to the fact that locomotive builders in this country are giving more attention to locomotive tender design than they have in the past, and drawings of several of the best designs have been collected for the purpose of illustrating the chief features of the improvements.

Chicago & Alton 6,000-Gallon Tender.

Some of the most original work in recent tender design has been done by the Brooks Locomotive Works and the tenders for the eight-wheel passenger locomotives built for the Chicago & Alton Railroad (illustrated in the American Engineer February, 1900, page 55), built by this firm, have been admired by all who have seen them. Fig. 1 shows the steel frame for the tank which is 22 feet long and has a capacity of 6,000 gallons. It is composed principally of heavy 13-inch channels, four of them forming the longitudinal sills. They butt against 13-inch channels at the front and back as end sills. The frame stands high with the lower face of the channels 37½ inches above top of the rails. This allows the straight drawbars, front and rear, to pass entirely under the end sills, and the rear bar is arranged with a pin connection to the tender and the yoke for an M. C. B. coupler. The front connection to the engine is fitted with a spring buffer.

The center sills are spaced 23 inches apart and this space is spanned at four places by heavy box-flanged castings, two of them forming the body center plates, and two of them the front and rear drawbar connections. The cross bracing on the lower flanges is made of 9 by ½ inch plates each side of the center plates and diagonal braces at the central portion of the frame made of 9 by ⅜ inch plates. On the top of the frame there are cross braces 18 by ⅜ inches at the front and rear ends. At the bolsters there are wide plates 21 by ½ inches, which are riveted to the tops of the center sills, and pass diagonally to the bottom of outside sills. It will be seen that this tender frame is very substantial, and is a good example of straightforward design.

The water tank for this tender is shown in Fig. 2. It has a capacity of 6,000 gallons, and the coal space will hold 12 tons of coal. The tank is 22 feet long and 9 feet 8 inches wide. There are no water legs, but the water space extends the full width clear to the front. It is only 18 inches high at the extreme front end, and inclines with a gradual slope to a point 44 inches back, where the depth is 21 inches; from this point it slopes to its full height, 90 inches from the back end. On top of this large incline the coal space is also the full width of the tank. At the front end it is narrowed in to 58 inches and closed by hinged iron doors, instead of the usual rough temporary boards. The corner spaces thus made in front are utilized for tool, clothes and oil boxes. The coal sides are curved out after the English fashion to a radius of 7 inches and finished neatly with 1¼-inch half-round iron. The vertical sides of both coal and water spaces are braced by 4½ by 3 inch tee irons spaced 33 inches apart. Diagonal bracing in the water space is made of plates.

The truck for this tender is shown in Figs. 3 and 4. It is a heavy diamond truck with M. C. B. 80,000-pound axles and elliptic springs. The bolster is made up of three 9-inch I beams. The arch bars are heavier than the M. C. B. recommended practice, as they are 5 inches wide and the top one 1½ inches thick. This tender weighs empty about 46,000 pounds.

Lake Shore Tender for Fast Passenger Service.

Another and very different design for a tender tank by the same builders for the heavy ten-wheel passenger locomotives for the Lake Shore & Michigan Southern is shown in Fig. 5. This engine was illustrated in this journal in November, 1899,

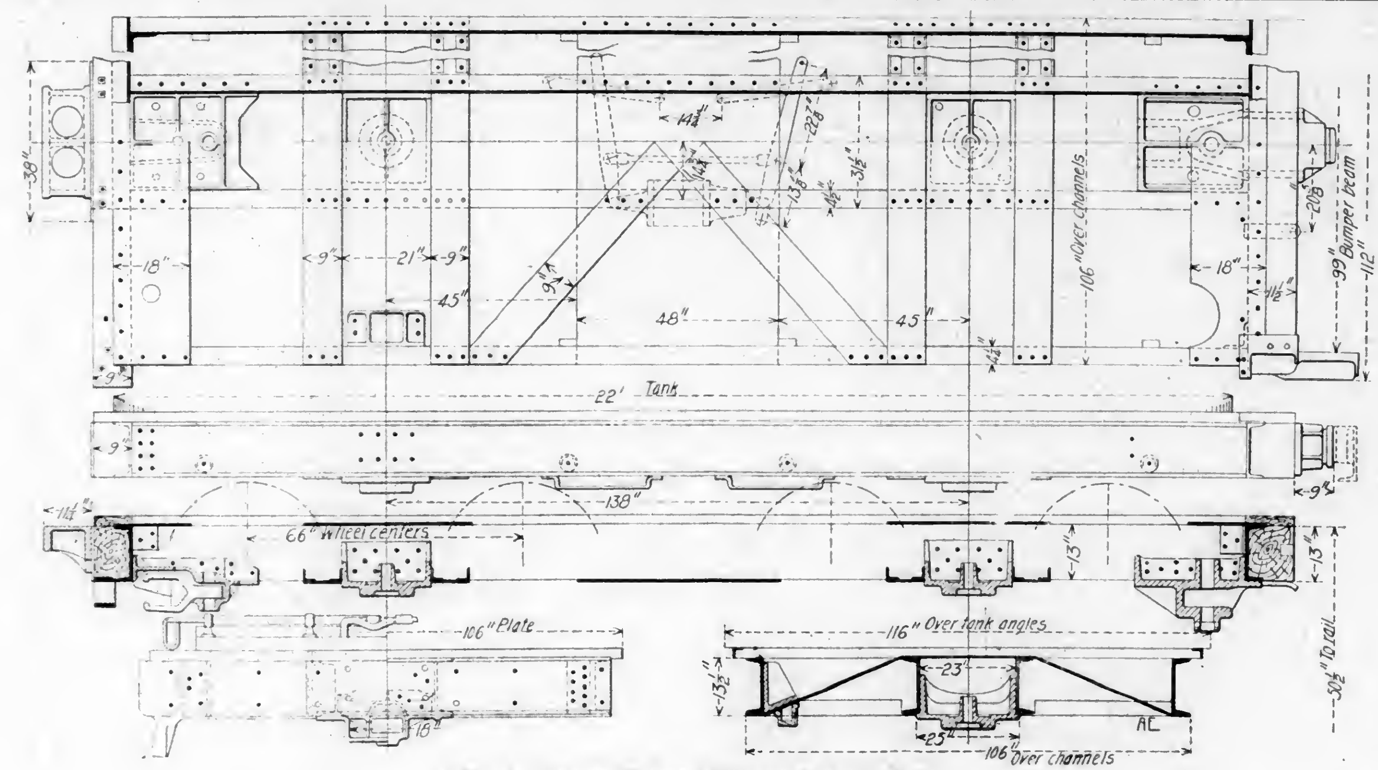


Fig. 1.—Tender Frame, Chicago & Alton R. R.

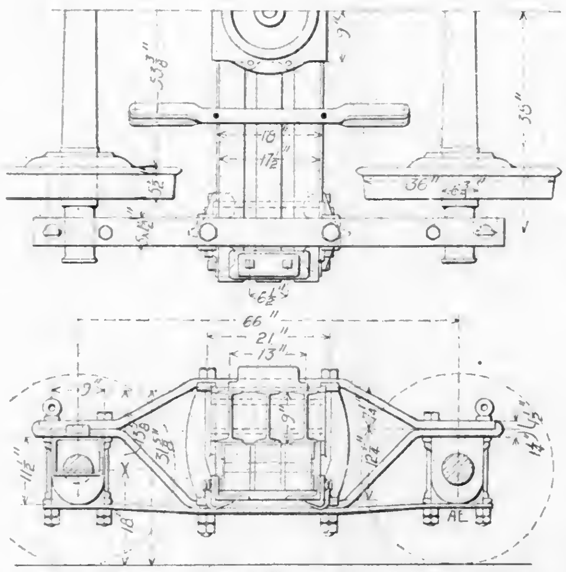


Fig. 3 —Tender Truck, Brooks Locomotive Works.

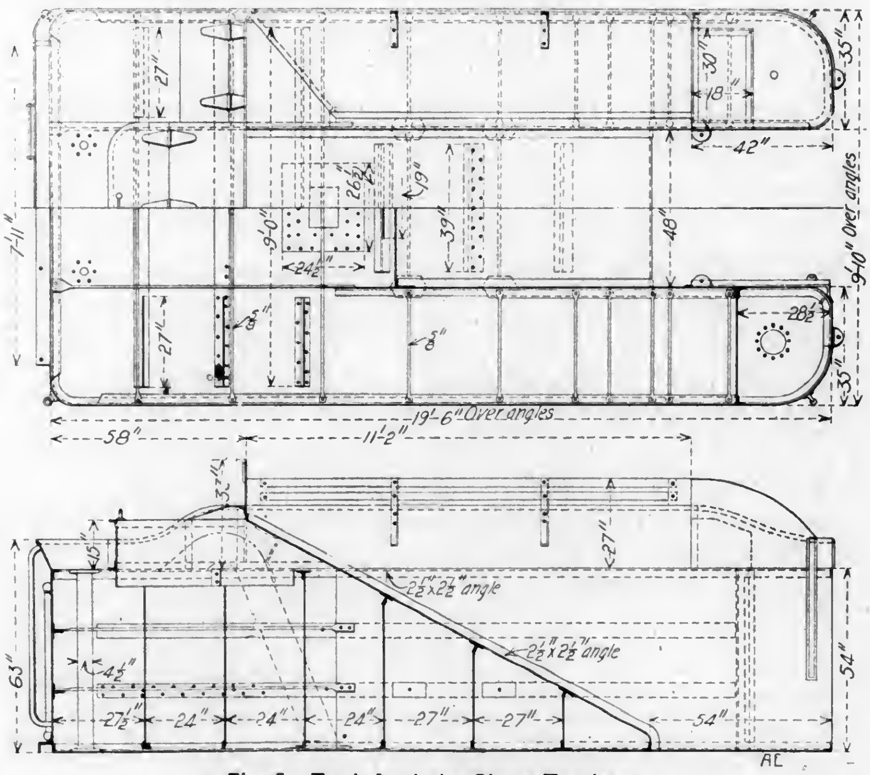


Fig. 5.—Tank for Lake Shore Tenders.

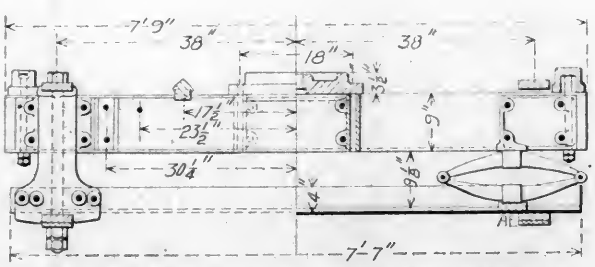


Fig. 4.—Tender Truck, Brooks Locomotive Works.

page 344. This tank is U-shaped with an unusually long slope to the coal space. The water capacity is 5,150 gallons and the tenders are equipped with water scoops. The bracing inside the water space is made of 4½ by 3 inch tees, connected across by ⅝-inch round bars with jaws for ⅝-inch pins. There are two rows of these cross braces spaced 18 inches apart, the tank being 54 inches high. Both of these tenders have elongated manholes for taking water and both are very neat in appearance.

Chicago, Burlington & Quincy Six-Wheel Tender.

Fig. 6 shows the six-wheel tender built by the Baldwin Locomotive Works for the Chicago, Burlington & Quincy Rail-

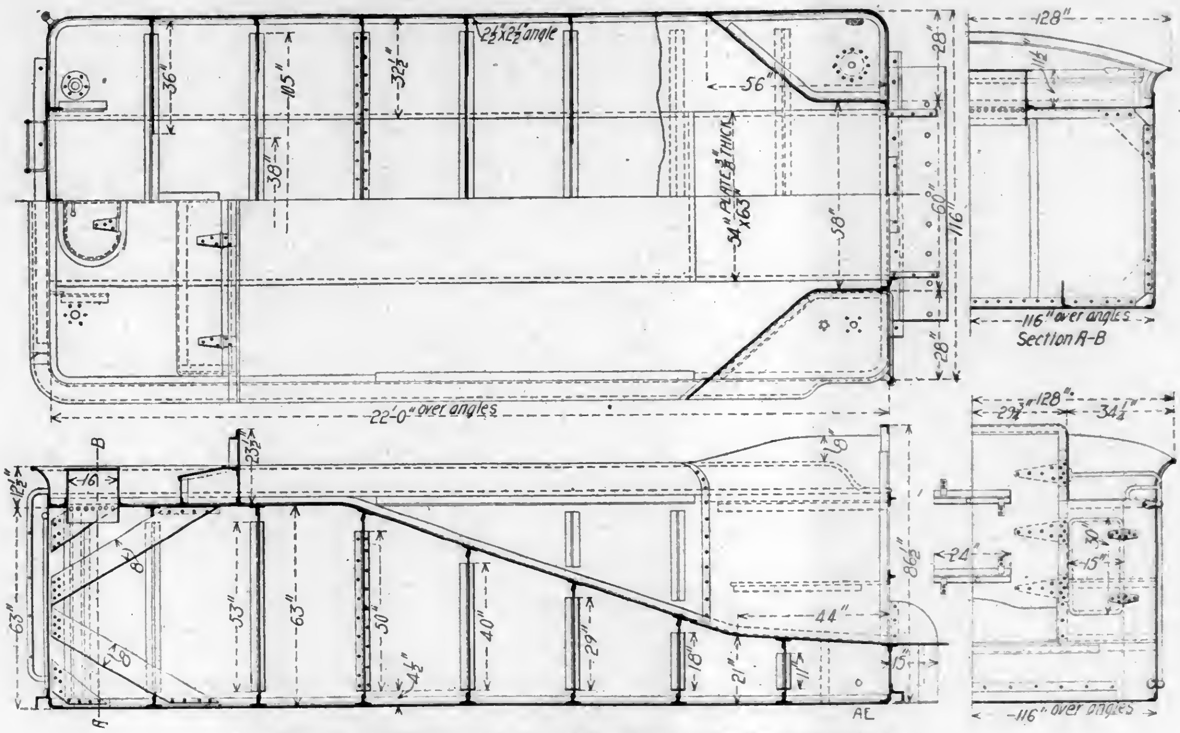


Fig. 2.—6,000-Gallon Tanks for Chicago & Alton Tenders.

road, and shown in this paper in May, 1899, page 141. The deep side frames are made of ¾-inch plates cut out for pedestals made of cast angles. The center sills are 9-inch channels. The end plates are 1 by 10 inches with oak sills 10 by 12 inches at the front and 9 by 10 inches at the rear. The wheels are 42 inches in diameter and the journals 6¼ by 10 inches. The front and middle wheels are equalized, the springs and equalizers being inside the main side plate frames. The capacity of the tank is 4,200 gallons of water and 8 tons of coal. The weight of the tender empty is 36,800 pounds. The loaded tender weighs 86,000 pounds, making the weight per journal about 14,000 pounds. It will be noticed that this tender is much lighter than those with four-wheel trucks, but when larger capacity is desired the weight per journal becomes excessive and in recent Atlantic-type engines for this road the tenders have four-wheel trucks.

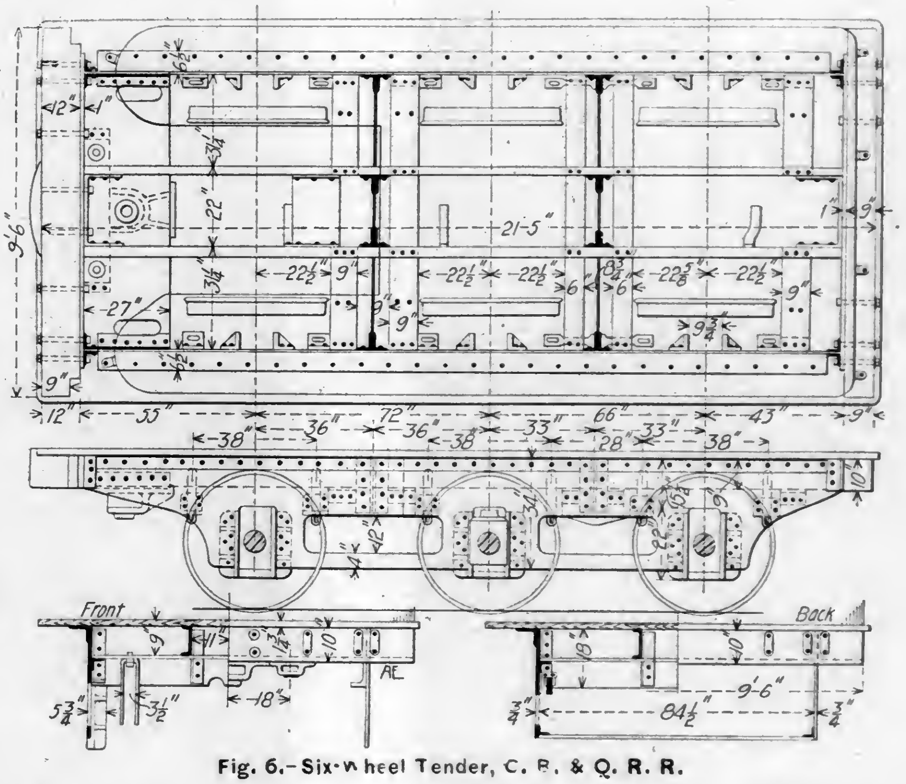


Fig. 6.—Six-Wheel Tender, C. B. & Q. R. R.

New York Central Standard Tenders.

On the New York Central a standard tender frame and tender has been adopted for use in new construction and in replacements, except for switching service in case a sloping tank is needed, one size and style of tender and frame being used for all engines. The construction is shown in Figs. 7 and 8. The side and center sills are 10-inch, 26-pound channels, secured at their ends by heavy bent brackets to plates extending across the frames and to these the wooden end sills are bolted. The top faces of the longitudinal sills are tied together by ⅜-inch plates 32 inches wide over the bolsters and by a third plate 5/16-inch thick and 54 inches wide at the center of the frame. The form and substantial character of the draft castings may be seen in Fig. 8. This is a very simple and strong frame. The total length over the timbers is 21 feet. The tank is 19 feet 10 inches long inside and holds 5,000 gallons. They are all equipped with water scoops and it is the intention to use the track tanks for freight as well as passenger service. This tank is braced with 4 by 4 by ½ inch tees as indicated in Fig. 7. The manhole in this case is 18 inches wide and 48 inches long, the larger dimension being parallel with the track. A half end view and section through the tees at the joints are shown in Fig. 7. The sides are stayed with tees which are crimped over the top and bottom angles and there are no cross ties, entire dependence being placed on the vertical tees. The top is also stiffened by tees.

When small tenders are needed for old engines new standard 5,000-gallon tenders are built and put behind the best engines that are several years old, the smaller tenders being released for use with the smaller engines. In this way all the expendi-

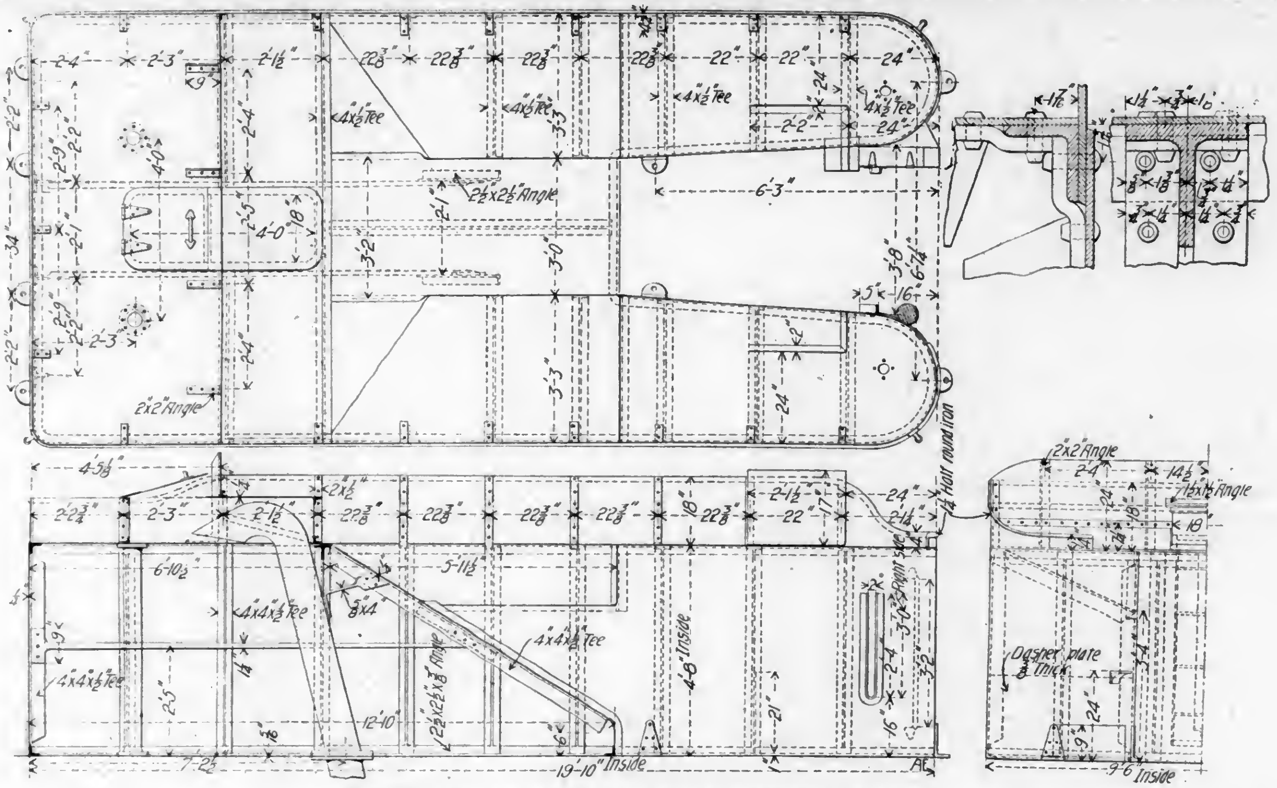


Fig. 7.—Tank for New York Central Standard Tenders

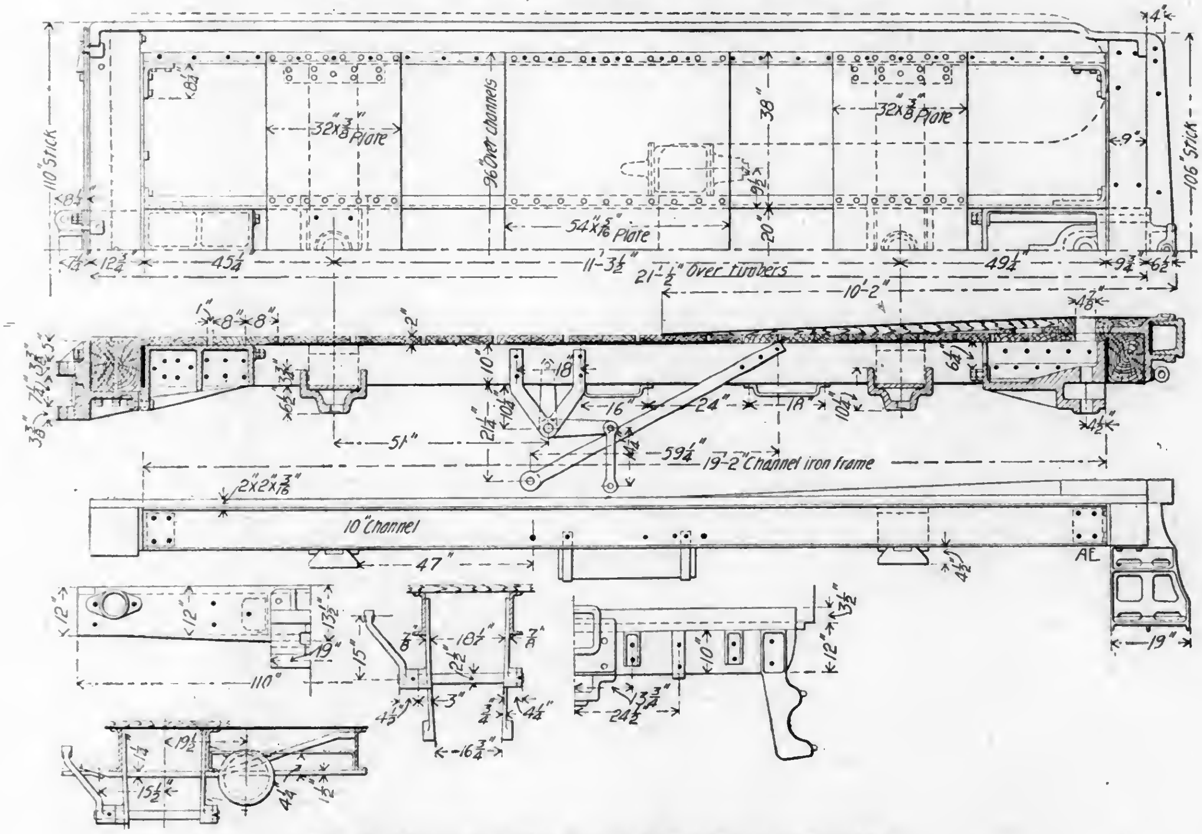


Fig. 8.—Frame for New York Central Standard Tenders.

ture for new tenders will be made in the line of standardizing and the best tenders will be available for the best engines. This practice will save the road a great deal of money and when necessary new requirements may be met by new standards. We are informed that this tender frame is likely to be adopted as standard by one of the most prominent of the locomotive builders. Fox pressed steel tender trucks with elliptic springs are used under all new tenders and Mr. Waitt says that he has had very satisfactory results with them.

The idea of using a single design for passenger, freight and switching service seems to have much to recommend it. The only change made for the various engines is in the center castings to suit the various diameters of wheels and in putting buffer castings on the rear of passenger tenders. In all these tenders the Master Mechanics' Association steps are used on both ends and unusual attention has been given to the hand holds.

(To be continued.)

FREIGHT CAR DRAFT GEARS.

By Edward Grafstrom, Mechanical Engineer Atchison, Topeka & Santa Fe Ry.

If we are to place any reliance whatever in the signs and portents of the times, it seems that the immediate future will solve the problem of draft rigging for freight cars. Although no one not personally connected with the M. C. B. committee having the subject in hand can surmise in what line the investigations have been made, upon which the committee's report at the coming convention will be based, yet the names of the members are a sufficient guarantee that an interesting and valuable report will be forthcoming. The admirable manner in which the M. C. B. coupler committee acquitted itself of its difficult task at last year's convention shows what can be done by diligent and systematic treatment, and though it is not known at the present writing whether or not that committee, as such, has since developed its subject further, yet it is understood that some, at least, of its members have carried on road tests individually, the results of which will presumably be given at the convention this year, thus enabling the association, with the information already at hand, to dispose of that subject intelligently. The draft rigging question, on the contrary, has remained in its embryo state, as far as the association is concerned, but the signs of the time point to important as well as necessary evolutions in the near future.

The M. C. B. Draft Rigging.

What is now generally known as the M. C. B. recommended draft rigging is nothing more nor less than the antequated adjunct to the original draw head, and its principal, if not its only, merit is that it is no one's patent. Since it came into existence the draw head has changed into the vertical plane coupler, and the latter has undergone a number of modifications from time to time, while the draft rigging, notwithstanding its modifications of 1897, has by reason of its design been found impossible by most of the leading roads, and in consequence a number of new types have sprung up. The car contract shops prefer to adhere to the M. C. B. draft rigging, however, unless it is otherwise specified in the contracts, for the reason that it relieves them of all responsibilty in that connection, and many of the railroads are also prone to shift the responsibility on the association instead of protecting their individual interests by the use of more suitable designs. With the introduction of 80,000 and 100,000 lbs. cars, however, the association cannot afford to continue to lend its name to the old device, and its remains for the committee to point out what shall take its place.

Modern Draft Rigging.

A few years ago the late D. L. Barnes wrote an interesting and comprehensive paper on freight car draft riggings, reviewing and comparing those in use at the time, and what he said then has undoubtedly served to guide many railroad officials in selecting designs other than the M. C. B. Yet it must not be forgotten that at that time the tail stem was used exclusively, and many of the draft riggings which he indorsed as strong and durable when gauged by the strength of the tail stem, have not lent themselves equally well to the adaption of the tail strap attachment. The Graham should be mentioned in particular as having been one of those which Mr. Barnes singled out for its strength and simplicity. Yet it is not well suited to the use of the tail strap, and neither the Mitchell nor the Potter adaptation of the tail strap have succeeded to make the Graham draft rigging as strong as it originally was, although, of course, the strap itself gives or should give more strength than the stem, at least as far as its fastenings are concerned.

It is not the intention here to describe in detail the different forms of patented draft riggings in use at the present day; that has already been done from time to time in the technical press. Suffice it to say that the most of them are based on the same principle as the M. C. B. recommended type, with improvements of more or less merit, principally relating to the manner of securing the follower stops to the draft beams proper, these improvements taking the form of cases, continuous castings, etc. The Graham and the Dayton differ more from this original type than the others, and are unlike each other inasmuch as the Graham was originally designed for the use of the tail stem, while the Dayton was designed exclusively for the tail strap. Each of the patented draft riggings has, of course, its zealous adherents, many of them not without good reasons, and up to this time they have filled the requirements comparatively well.

Increased Spring Capacity.

The panic and following financial depression which prevailed during the years 1893-1897 affected the railroads in one noticeable way: railroad managers studied carefully the question of hauling the greatest amount of freight over the road at the least possible expense. As a result the tonnage rating came into general use, thereupon locomotives of the largest practicable types took the places of lighter ones, and finally freight car capacity commenced to grow up to the present limit of 50 tons. The effect of these increased tractive resistances told on the coupler and draft rigging, and with special regard to the latter it soon became understood that the 1896 M. C. B. spring of 19,000 lbs. was entirely inadequate under the changed conditions. To increase the size of the spring was found impracticable, as the steel bar was already as large as the spring makers cared to guarantee. Recourse could therefore be had only to doubling the spring, and then a new crop of draft riggings sprung up, some with tandem, some with twin springs. Many of these were modifications of previously existing forms which lent themselves to one or the other method of doubling up the spring, while others were entirely new forms designed to meet the new conditions. Manufacturers of draft riggings dare not nowadays compete for the business unless they have a double spring article to offer, and very few new cars will be built hereafter with single springs, except perhaps on roads where the hauling capacity of the locomotives is limited.

It is not of paramount importance to discuss which arrangement of springs is preferable, for the question cannot properly be decided without considering the relative merits of the draft riggings themselves, and also the construction of the cars on which they are used. Some people object to the twin spring for the reason that should one spring break, the follower or its equivalent would tilt to one side, which might damage other parts. It should be said here, however, that if the draft rigging is properly designedthe springs should never be allowed to be compressed solid. This not only preserves the springs, but it also prevents excessive tilting in a twin spring arrangement in case of a broken spring, and in a tandem arrangement under the same cirumstances it prevents the coupler from being pulled out so far as to strain the unlocking chain.

The principal objection to a tandem spring arrangement is that it occupies more length, or, in other words, requires the bolster to be spaced further from the end sill than is desirable, for it is a recognized fact that unless an unusual amount of side play is allowed to the couplers in the chafing irons, too much overhang beyond the trucks throws undue strain on the knuckles and is apt to cause uncoupling on a sharp curve. In most of the tandem spring designs it will also be found that the tail strap is one of the weakest parts, unless made heavier than usual, on account of the necessary fastenings for the intermediate follower.

The Westinghouse Friction Draft Gear.

The recent demand for increased capacity has again brought this device into prominence. So much has been said and written about it that it is here only necessary to define its position relative to other draft riggings. The difference in action of spring and friction resistance is clearly explained in a recent

communication from Mr. E. M. Herr, from which the following is quoted with his permission:

"The problem of the best draft rigging is to obtain the maximum of yielding resistance with the minimum of recoil. . . . It is clear that the above conditions cannot be met with any springs or combination of springs. They furnish the yielding resistance, but the recoil is almost as great, for the energy absorbed by springs is merely transformed from kinetic to potential, and is again restored to kinetic energy as soon as the pressure is removed. The underlying principle of the friction draft gear is that it actually destroys the energy, which would otherwise be damaging to the cars, while in all other forms this energy is only dissipated in actual work on the cars."

The practical limit of spring resistance has probably been reached with the use of two 19,000-lb. springs. To go much beyond this would be unsafe, until couplers and cars are made considerably stronger. For present conditions the two springs seem to be sufficient. No well-informed railroad man has any doubt as to the merits of the friction gear; that it comes nearer being a perfect draft rigging than anything else so far designed is generally conceded, and those who have tried it know that it does the work well.

The Coming M. C. B. Draft Rigging.

It is a fact worth recording in this connection that the present trend of popular taste is indicated by the desire for substantial double-spring draft riggings. The popularity of cheap, home-made articles, which came into vogue on many roads during the financial depression of the last few years, commenced to wane when the heavy steel car was reared. We should not, however, look for any special type or design as worthy of the honor of being the sole possessor of the M. C. B. endorsement. Interchangeability cannot even be expected, as in the case of the couplers. But there are certain fundamental principles which the approved draft rigging should conform to, and these are:

1st, They must have the necessary strength.

2d, They should take standard springs.

3d. These springs should not be allowed to compress solid. As springs of the same make vary in height, a limit should be set within which no springs could be compressed solid.

4th, Not more than one or two lengths of tail straps should be allowed.

By laying down a few broad specifications of this nature, and narrowing them up from time to time, it may be possible that the number of draft riggings could be considerably reduced, and coming inventors would confine their exertions within certain bounds. It would also be more or less of a protection from receiving foreign cars with inferior draft riggings, incapable of being hauled indiscriminately in heavy trains. Lastly, it would tend to reduce to a minimum the material necessary to keep in store for repairs, without interfering with the expeditious handling of the cars.

Mr. McIntosh present an interesting firebox design in his article in this issue. He may expect additional advantages from the division of the firebox into two chambers with a fire door to each. The effect will be to improve combustion by always having one of the doors closed and one side of the firebox sending hot gases to the tubes, while the other side is chilled by the open door and the addition of green coal. This is believed to be a very important feature of the plan. A similar arrangement would probably tend toward "smokelessness" in soft coal burning, and the idea is commended to those who are considering larger grates for soft coal.

We take this occasion to express our gratification that our efforts to present valuable information in these pages are meeting substantial support in a rapidly increasing subscription list. A larger number of railroad men with responsibilities in design, construction and maintenance of locomotives and cars have been added since January 1 than during any similar period in the history of the paper.

THE COST OF RUNNING FAST TRAINS.

Locomotive Fuel Consumption.

By G. R. Henderson,

Assistant Superintendent of Motive Power, Chicago & North Western Railway.

That an increase in speed of trains is accompanied by a higher fuel rate per mile has long been recognized, and was very ably presented by Mr. F. A. Delano, Superintendent of Motive Power of the Chicago, Burlington & Quincy Railroad, in a paper before the Western Railway Club last winter. The actual rate of increase, however, has not, so far as is known to the writer, been determined.

Progressive railroads follow the coal consumption by locomotives with care and watchfulness and make comparisons with previous years. These comparisons are almost worthless without a unit of work as a basis, and the ton-mile has come to be recognized as a suitable unit for this purpose. These comparisons may not always be favorable, unless the rate of speed has been kept constant or nearly so since the previous date with which the comparison is made. As the general tendency now is toward such an increase of speed, it becomes necessary to explain the corresponding apparent extravagance in the use of coal.

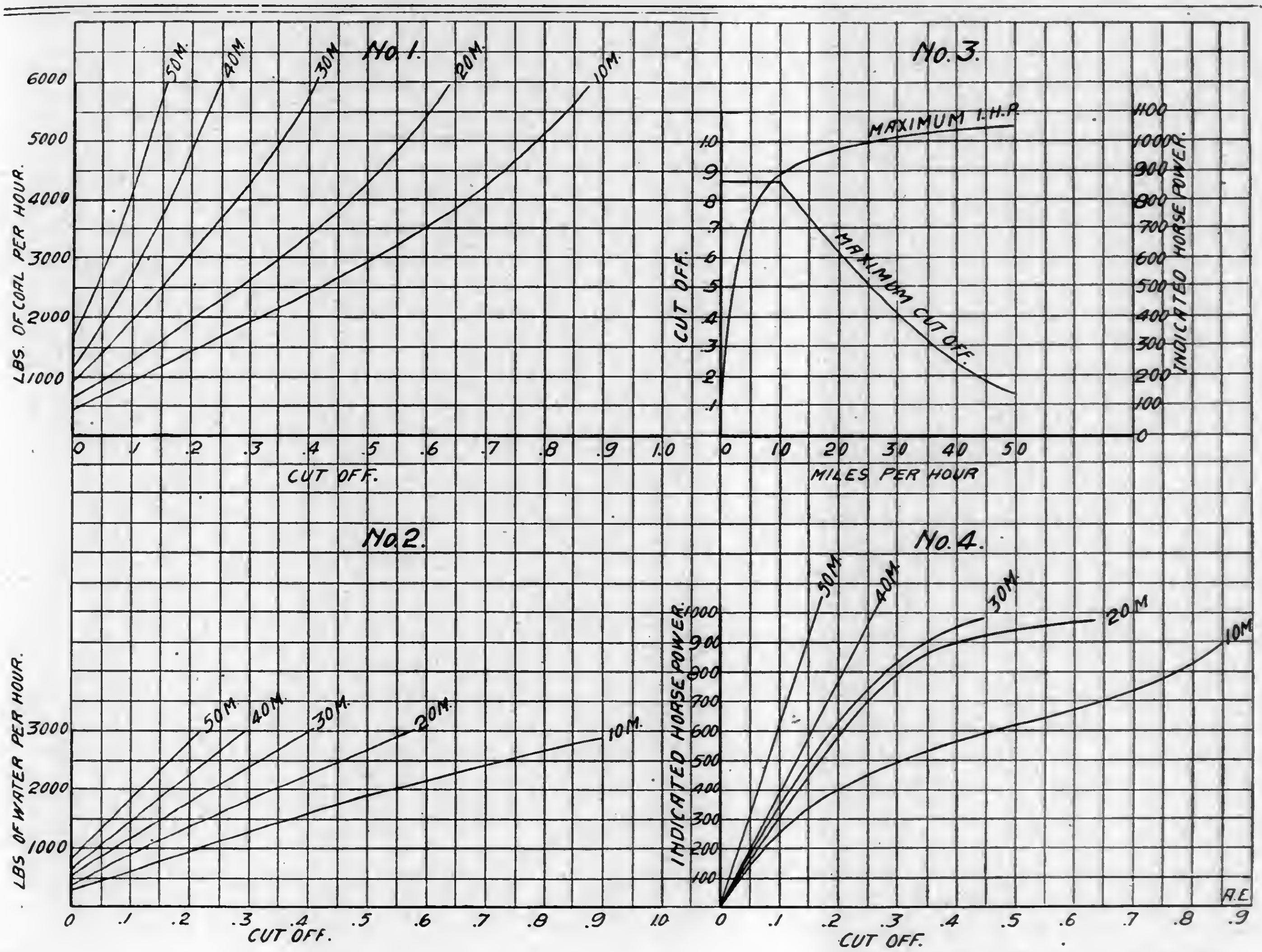
It was therefore decided by the Chicago & North Western Railway to institute a series of tests that would demonstrate, practically, the real values of the question. The unsatisfactory measurement of coal and water and the impossibility of maintaining constant conditions for any length of time in a road test were sufficient arguments for making this portion of the experiment upon the locomotive testing apparatus with which this road is equipped. The rate of coal and water consumption for a series of speeds and cut-offs being known, it would be easy to determine what could be expected under any conditions. It was also the intention to make road tests later with a dynamometer car, in order to determine the effective pull behind the tender in the same series of tests as on the plant, and finally to measure the increased resistance due to speed of a train over a complete division of the road.

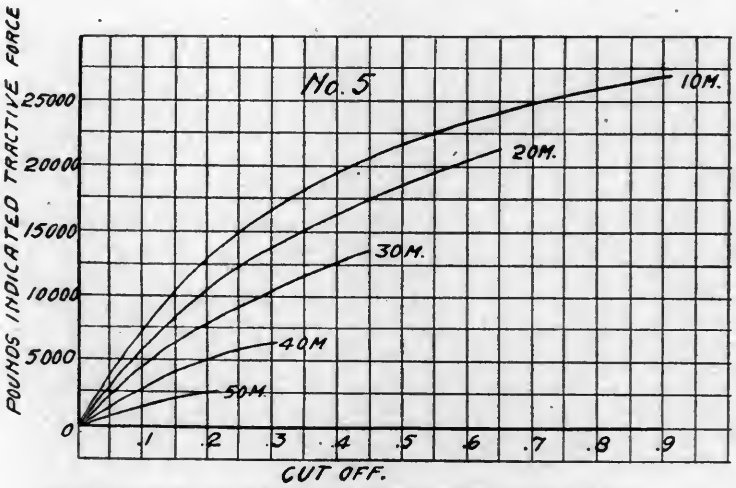
The dynamometer car tests not yet having been commenced, this article will treat only of the results obtained on the test plant. The locomotive tested was the standard heavy 10-wheel freight engine of the Chicago & North Western Railway, known as "Class R," and has the following general dimensions and weights:

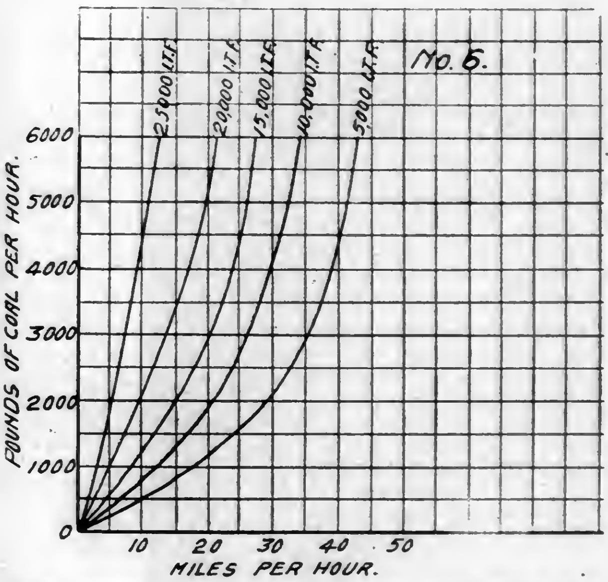
Cylinders	20 by 26 in.
Driving wheels, diameter	63 in.
Steam pressure	190 lbs
Boiler diameter, front	64¼ in.
Grate area	29 sq. ft.
Heating surface	2,332 sq. ft.
Weight on drivers	118,350 lbs.
Weight of engine	153,000 lbs.
Steam ports	1⅝ by 16 in.
Exhaust ports	3 by 16 in.
Allen American balanced valve.	
Outside lap	⅞ in.
Inside clearance	0 in.
Valve travel	5½ in.
Lead about ¼ in. at 6-in. cut-off.	

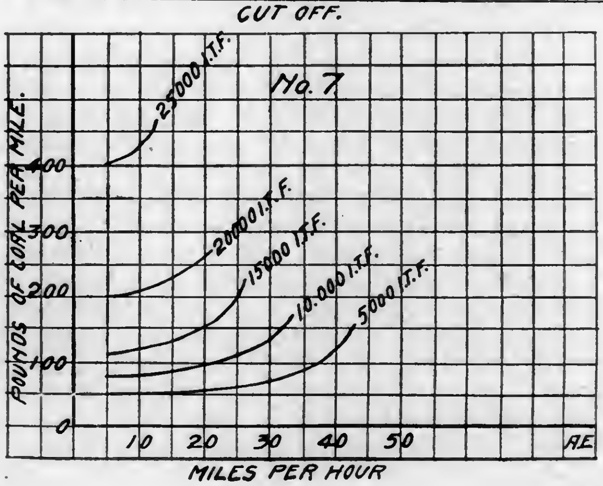
The intention was to run each test long enough to insure maintaining conditions, but the rapid wear of the brake shoes on the brake wheels of the plant sometimes prevented as long tests as were desired. All water measurements were carefully made, the coal was weighed, indicator diagrams were taken every ten minutes from both cylinders and pressures and temperatures were recorded, so that we think the results will give a fairly correct indication of what may be expected in practice. Ordinary freight coal from Indiana was used and no attempt was made to get exceptional or "fancy" results. The accompanying diagrams were plotted from these tests as far as they went, and in some cases the loci have been extended beyond the range of the tests, where it was thought their direction was sufficiently indicated.

Diagram No. 1 shows the pounds of coal per hour for various









speeds and cut-offs. These loci have their real origin 0.08 to the left of the diagram, corresponding to the approximate clearance of the cylinders. As would be expected, the rate of combustion increases faster than the rate of cut-off, but not quite as much as was expected. This may be explained by diagram No. 2, where it will be seen that the water used increases slower than the rate of cut-off, and we have thought that this may be due to decreased cylinder condensation at late cut-offs.

These diagrams show that the limit of the boiler is at 200 pounds of coal per square foot of grate area per hour, which in this engine means three tons of coal per hour. This limit fixes the maximum cut-off possible at the various speeds and diagram No. 3 illustrates this, as well as the maximum horse

power obtained. No. 4 gives the horse-power curves for the same series as No. 1. Diagram No. 5 illustrates the variation in indicated tractive force for various speeds and cut-offs. In all these tests the throttle had full opening. No. 6 gives the pounds of coal per hour for different rates of indicated tractive force at various speeds and No. 7 gives the same per mile. This shows what increase in the coal bill may be expected with increase in speeds, although this does not consider the increase in train resistance also due to increase in speed.

The well-known formula on train resistance will enable anyone to combine it with diagram No. 7 and by allowing the proper percentage for internal friction and the resistance of the engine and tender considered as heavy cars, the coal consumption per ton of train may be obtained. These we expect to demonstrate practically with the dynamometer car, however, and will then be in a position to give actual results.

THE ARRANGEMENT OF BOILER SHOPS.

By F. M. Whyte, Mechanical Engineer, New York Central & Hudson River Railroad.

The declaration that it will be found desirable, if, indeed, not necessary, to study the "state of the art" in boiler shop design before beginning plans for a new shop, if a fair measure of success is to be assured, will probably not be questioned, and while any new or old ideas here recorded would be better fortified with line drawings and descriptions of present shops, it is considered beyond the scope of this article to make it, to any extent, historical. References will be made to present shops merely with the intention of illustrating the point under consideration, and the particular shop will not be mentioned.

In the designs of boiler shops too little attention has been given to the kind of work to be done in the particular shop; a contract shop, where by far the larger part of the work is to be building, should receive different treatment from a shop in which a larger part of the work is to be repairing. In the one case the movements of material are largely in one direction, toward the place where the boiler is assembled; in the other the movements are largely in both directions, distributing the material from the boiler and then assembling it again; the movements must be harmonious for the particular conditions and continuous, if best results are to be obtained. The work done in the repair shop is also very different from that done in a building shop. The location of the shop also will be governed partly by the kind of work to be done in it, and whether the shop is to be thoroughly equipped, or it is to be dependent upon other shops for the use of certain machines, will need to be considered.

It is probable that the consideration of a boiler shop forming a part of a locomotive repair plant will interest the greater number of readers, and for this reason, and because the subject may be limited advantageously in this way, effort will be made to keep within these bounds.

If a choice of locations is possible, that one should be selected which will be most convenient for the transfer of boilers from and to the main erecting shop, and, if the boiler shop is to be thoroughly equipped so as to be independent of other shops for the use of tools, such transfer of boilers should control the location of the shop. If, however, the boiler shop is to depend upon the blacksmith shop for heading and upsetting bolts, and for various small forgings, and upon the machine shop for the use of planers, shapers and lathes, then the convenience of transfer of boilers may well be sacrificed for a location more convenient for the many trips to be made between boiler shop and blacksmith and machine shops for the smaller articles. Other considerations may fix the location of the boiler shop; if there is no transfer table, and the tracks in the erecting shop extend longitudinally, then it may be most convenient to locate the boiler shop at one end of the machine shop, or in such other location that the boilers can be moved from one to the other without too much switching; if the tracks in the erecting shop are transverse, a transfer table will probably be provided, and under such conditions the boiler shop should be located, other things being equal, on the other side of the transfer table, though not necessarily directly opposite the erecting shop. The explanation for this will bring up the much mooted question of longitudinal and transverse tracks in shops, but this question will be considered only so far as the subject under consideration seems to require.

In those erecting shops having the machinery on one side and transverse pits on the other, it will be best to "head" the engines out, because this will bring the more particular work of erecting nearest to the source of light; the work inside the smokebox can be done without artificial light being used all the time; when tubes are removed in the erecting shop, as is frequently done, they can be put directly out of the shop and out of the way; and engine trucks may be transferred readily to a particular part of the erecting shop or to some other shop where special appliances can be provided to facilitate truck repairs. This will leave the driving wheels as the only very heavy parts to be handled inside of the shop. Where the locomotives are "headed" in, the more particular machinery work will be away from the light; the smokebox work cannot be done as well without artificial light most of the time, and the inside firebox work cannot be done without artificial light anyway; and the tubes must be turned around after being taken out and carried the length of the engine, and so interfere with the other work on the engine, or they must be trucked through the shop. On the other hand, boilers should be placed in the boiler shop with the firebox end placed nearest the source of most light (and this is generally at the side where the boiler is brought into the shop), because most of the repair work is done on the firebox end. Thus it will be seen that, to avoid turning the boiler when it is being taken from one shop to the other, and to place it most advantageously in either shop, the erecting shop and boiler shop should be on opposite sides of the transfer table.

It has been suggested that the boiler shop should be an extension of the erecting shop, so that the same traveling crane would serve both; this may be satisfactory in small plants where the combined demands of both shops would not exceed the capacity of the crane; otherwise, there is likely to be much friction between shop foremen and considerable waiting, and these quickly lessen the value of the crane.

The cross-section and elevation of the shop will require much study, particularly in the first attempt, and an examination of the arrangements of the more modern shops will prove of inestimable value; but care must be taken lest peculiarities of construction made necessary by unavoidable conditions be misunderstood as approved design. For a shop of large capacity, doing mostly new work, the design that seems most satisfactory, and the one followed in a number of the more modern shops, is that having a central bay of sufficient width for the work to be handled, and the roof over the bay placed at such elevation as to give ample clearance for the main cranes, as these span the bay. On each side of the bay is a wing, the roof of which need not be so high as that over the bay. The width of the wings must be decided with as much care as that given to the consideration of the width of the bay, and by way of caution it may be remarked that the wings of a number of modern boiler shops have been found to be too narrow to allow of convenient transfer of material from one machine to another, the machines being located in these wings.

A standard-gauge track should extend into the building and be accessible to the main cranes, to facilitate unloading material and loading finished product. The two wings will allow separating the work on rolled and flanged sheets, and the former can be advanced through flange punches and shears and drills to the assembling floor, while the latter can be advanced through shears, planers, punches and rolls to the assembling

floor near the riveting machine. The wings can be provided with light-capacity overhead cranes, or with one or more overhead trolley tracks, because boiler shop machine tools are of such heavy capacity and of such intermittent action that they may well be driven by separate motors, and thus the overhead shafting be dispensed with, the lighter machine tools being grouped together and driven from a short main shaft.

The main bay, with high roof for the accommodation of a large-capacity crane, will be the essential of any thoroughly equipped boiler shop, and whether there will be a wing along one or both sides of the bay will be decided by circumstances. The two will be found most convenient for a large output of new work. The riveting tower, or towers, should be placed at one end of the bay, and at the end of the shop opposite to that where space is left for extension; this location will allow of extending the shop without disturbing the towers, and will make it possible to serve a part of the floor space with the main crane and the tower traveler, thus facilitating transfer of loads from one to the other.

The flange fires and furnaces should be isolated from the main shop so as to keep the latter free of smoke, and the isolation may be accomplished with satisfactory results by means of a partition wall between the flange room and main shop. Attempts have been, and are, made to accomplish the same results by placing adjustable hoods over the fires, but the men working about the fires generally feel that the others in the shop are no better than they are, and reason that if they can work in the smoke the others can, and as a result of this reasoning the hoods are soon pushed out of the way as far as possible and are allowed to rust in that position. It sometimes happens that the use of the hoods seems to be the best arrangement possible under the conditions prevailing, and under such circumstances they should not be criticised.

A flange press is a very necessary tool in a well-equipped boiler shop, and if the work justifies the installation of a press large enough to flange back heads of the locomotive type of boiler, then the facilities to be provided for handling the heavy dies will fix the location of the press and also of the furnaces serving it. In a number of shops where flange presses are used the main crane is depended upon for handling the heavy dies, and this dependence has made it necessary to use a part of the floor space of the bay as storage for the dies. Those who have adopted these means will not recommend the practice, and in a new shop provision should be made to obviate such use of the most valuable floor space. Probably the best arrangement is to have storage room for formers outside the shop, and an overhead hoist commanding the storage space can be provided without great cost. The storage space should be of sufficient area to require as little stacking of the formers as possible. When the dies are stored in the shop they are piled high to economize in floor space, and as they are generally required in the "chain gang" order, "first in, first out," the one wanted is generally at the bottom of the pile, and the expense of getting it is considerable. The formers would be more accessible, whether stored in the shop or in a storage yard, if stood on end, and so arranged they may be stacked two or three tiers high without lessening seriously the advantage of the arrangement.

Because most of the material used in a boiler shop is heavy, the cost for handling should be reduced as much as possible by reducing the amount of handling, and this will be accomplished in the highest degree by receiving shipments of material directly in the shop and locating the storage racks conveniently for the use of the crane in unloading. It is very important, if space allows, to stack the sheets, the larger ones at least, on edge, with the identification marks of each sheet exposed or as accessible as possible; this method of stacking the sheets is required for the most satisfactory working of the "chain gang rule," to which, like the press dies, the usual method of piling plates conforms.

Even the hasty manner in which the general arrangement of the shop has been treated in the above will not justify omitting all reference to two essentials of a first-class boiler shop which are very generally overlooked, if, indeed, not studiously neglected; the sanitary arrangements and the foreman's office. Too frequently the boiler shop, like the smith shop and the foundry, is considered to be outside the pale of sanitary laws, and the protection of street clothes is a nail on a dirty wall, the lavatory is a small can of oil and a piece of dirty waste, and a nuisance is made of the inside and outside of the walls of the building, and even of the crane-supporting columns. The modern shop has a neat, though plain, toilet room, either inside the shop, and elevated above the floor, or adjoining the shop, and located so as to require the least amount of time to reach it from all parts of the shop. It should have both entrance and exit doors, if possible, and these spaced several feet distant from each other. There should be one urinal and one seat for every eight or ten men. The lavatory should be convenient to the toilet room, though partitioned from it, and should be provided with hot and cold water and a wash bowl for every four or five men. There should be in the lavatory a locker for each man, the doors to the lockers to be made of wire netting or similar material, so that precaution may be taken against the accumulation of oily rags and also to facilitate cleaning.

The foreman's office should be located centrally in the shop, elevated above the floor, and at the same time out of the way of the cranes. The walls should be made of glass, as far as possible. The office need not be elaborate, and some will think that none is necessary because a foreman should be about the shop; but the foreman has duties and records which require an office, and frequently he needs a clerk. In addition to these reasons, a view of the shop at a little distance may have, sometimes, very remarkable results.

Locomotives designed throughout with a view of how good, how serviceable and efficient they can be made, are not too common, and it takes nothing from the credit merited by other good engines to express the opinion that the Class E 1 of the Pennsylvania, which is so thoroughly illustrated in this issue, represents in many respects the best design and construction that has appeared in this or any other country. Almost every detail exhibits features which will set locomotive men thinking. It has been very successful in meeting the conditions for which the design was prepared, the handling of the fast Atlantic City expresses. A large number of the details are presented, because they are believed to be good examples illustrating principles which have been found satisfactory. They do not always tend in the direction of inexpensive construction, but it is probable that first cost might be advantageously increased in many directions in view of the possibilities of saving in maintenance. The engine is noteworthy, first for the large grate, second for the free steam passages and the steam distribution, and, third, for the excellent details. The designers had in mind the improvement in construction with reference to the rigid connection between the cylinders and frames, and between the back ends of the frames; also the construction of parts whereby the taper fits of keys could be made entirely upon the planer. The ash pan, throttle valve, the main steam valves, the cylinders, the main rod, piston, piston rod, crosshead and other details possess unusual interest as a study of the locomotive. It is a pleasure and a privilege to be given the opportunity to describe and illustrate this engine, and those who cannot give such attention to details will find the description valuable for reading and for record. We desire to express our appreciation of the opportunity given by the officers of the road and for their painstaking kindness in assisting in the preparation of the description.

Mr. Thomas Tipton, Chief Store-keeper of the Rio Grande Western, has been appointed Purchasing Agent, with headquarters at Salt Lake City, Utah.

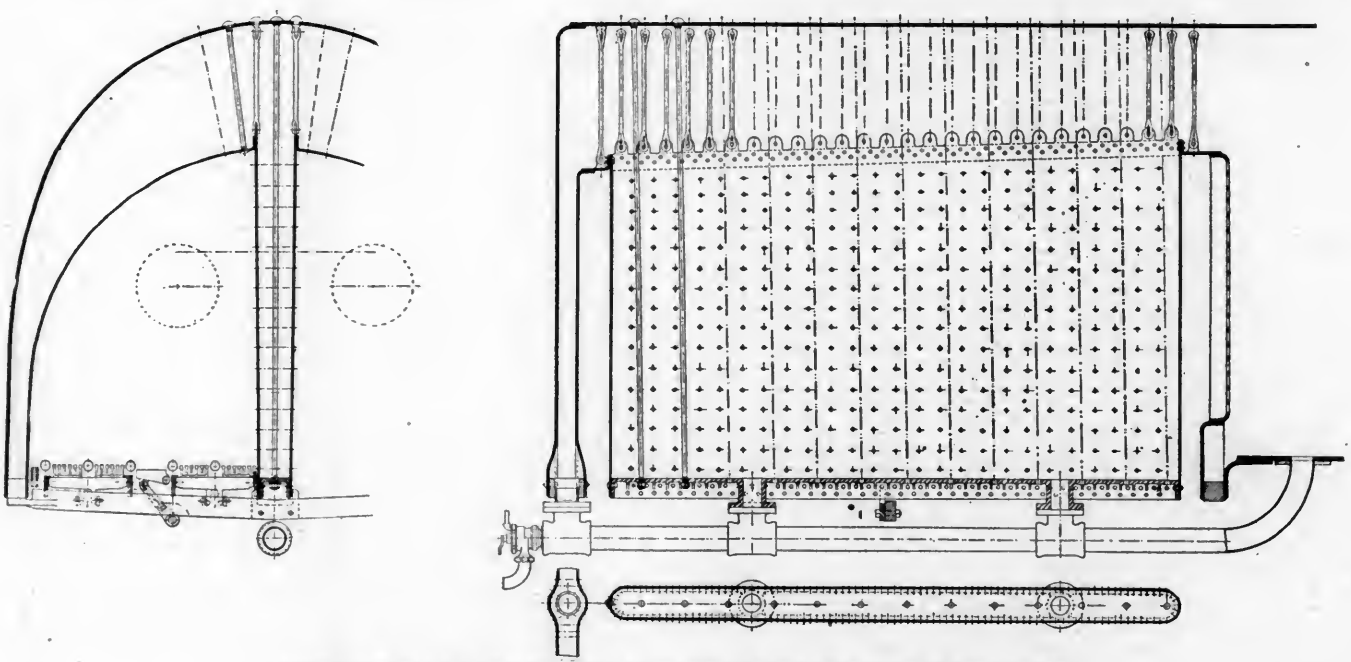
Mr. John J. Reid, formerly of the Rhode Island Locomotive Works, Providence, R. I., has been appointed foreman of machine shops of the Delaware, Lackawanna & Western, at Scranton, Pa., and, with his other duties, will have charge of the improvements about to be inaugurated at these shops.

CENTRAL WATER LEG APPLIED TO WOOTTEN FIRE BOXES.

By W. McIntosh, Superintendent of Motive Power, Central R. R. of New Jersey.

The wide fire box of the modified Wootten type is attracting a great deal of attention of late and will no doubt become more generally used as motive power and transportation people become better acquainted with its advantages, which lie principally in the large grate area, enabling it to steam with very inferior grades of fuel.

There is one disadvantage with the locomotive boiler, however, which is intensified in the Wootten type by reason of its greater extent, and that is the rather sluggish water circulation toward the extreme back end, the movement of the water in that direction being somewhat interruped by coming in contact with the intensely hot side sheets in its movement toward the rear. In an effort to improve the circulation in this type of boiler and at the same time provide more heating surface, I have designed a center water leg, extending from the crown sheet to the mud ring level, without other direct connections to the fire box, the water being supplied from the front and rear, as shown in the illustration, it being expected that the rear connection will accelerate the movement of the water passing the side sheets, thereby preventing overheating, while the general movement of the water toward the pipes below the mud ring will tend to carry to that point the incrusting matter being precipitated and from which point it can be blown out.



Central Water Leg for Wootten Fireboxes—Central Railroad of New Jersey.

No claim can be laid to novelty in applying this center water leg, as it has been generally used in marine service, and I think it was Milholland who brought out a design for a locomotive many years ago quite similar to the one now proposed, except that it was extended to the door and flue sheets and through the combustion chamber, where the seams would be apt to cause trouble by leaking, and another disadvantage that he labored under was in applying it to fire boxes of very small dimensions, where the grate area was insufficient to burn the fuel necessary to heat the ordinary walls of the fire box.

The dimensions of the Wootten box are large enough to receive this additional water leg and still allow ample grate surface, the small loss of grate space occupied by the water leg being many times compensated for by the large increase in heating surface which it furnishes. There should be no difficulty in welding the one connection of this water leg that is exposed to the action of the fire, so that there will be no seams in the firebox nor liability of trouble from that cause. The crown sheet should be flanged upward, where the seam connecting the flange and water leg, being entirely in the water, would also be safely protected from action of the fire.

The water leg sheet is intended to extend from above the connection to the crown sheet to provide lugs to which will be attached sling stays from the boiler, thereby insuring a convenient and reliable means of staying. In addition to this it is intended to run some long stay rods from the top of the boiler to the bottom of the auxiliary water leg, to relieve the other stays from the weight of water and metal suspended from the crown sheet. The tie bar that extends across the bottom of the firebox to prevent spreading is arranged to engage the auxiliary water leg, with a view to increasing its stability.

It is also proposed to use with this boiler a combination water tube and shaking grate, the latter to be of the Yingling type, each alternating section reversing its movement, which in connection with its small divisions has a tendency to work the fire effectually, while its large proportion of air space insures thorough combustion and guards against any possibility of overheating the fingers.

An alternate construction would be to substitute vertical tubes of the Babcock & Wilcox type in place of the proposed water leg, expanding the upper ends of the tubes into the crown sheet and the lower ends into suitable headers connecting to a longitudinal pipe of liberal dimensions, serving as a mud drum and connecting to the mud ring and the boiler shell in the same manner as the proposed water leg. Long stay rods would be run through the tubes from caps under the headers to the top of the boiler. I anticipate that with either form of construction the results would be much more favorable than could be figured out on a basis of additional heating surface.

The writer has long entertained the opinion that circulation at the rear of the rectangular fire box is decidedly sluggish, and experiments made some years ago on a small scale confirmed these views. If the center water leg will open up continuous circulation as expected, the result would be apparent in increased evaporation and a corresponding fuel economy, not brought about so much by increased heating surface (which would be about 80 square feet) as through the better absorption of heat by the continuous and regular movement of the water past the heating surface.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

No. XXVI.—The Ventilation of Passenger Cars.

By C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad.

It seems not improbable that if a vote of the general traveling public could be taken on the question as to what improvement or change in passenger cars at the present time would most conduce to the comfort of passenger travel, a very large majority of the ballots would be in favor of an improvement in car ventilation. It is to be confessed, we think, that the discomfort attendant on riding a number of hours in a stuffy, over-heated passenger car, and especially the annoyance and discomfort from spending the night in an over-heated, ill-ventilated Pullman car, are so great that it is not at all surprising that not only individual passengers but also the technical papers, and, indeed, the general press of the country, should from time to time break out into a tirade against the present condition of the ventilation of passenger cars. It is claimed that there are cases on record, where passenger car windows are fastened down, of passengers deliberately breaking the glass and paying for the same, in order that they might enjoy the benefit of fresh air. We think it fair to say, on the other hand, in justice to railroad officers, that the condition of affairs is not and has not been in the past entirely ignored by them. They are entirely conversant with the fact that the present passenger coach, and especially the Pullman car, is not properly ventilated, and it is not because of indifference, but because of the extreme difficulty of the problem that no more decided action has been taken in the past. If we succeed in what we have planned in this article, we think the difficulties to be overcome in the proper ventilation of passenger cars and the reasons for the present state of affairs, will be better understood by the general public, than they are at the present time.

The question of car ventilation has been studied more or less for a number of years. Under the auspices of the Railroad Commissioners of the State of Massachusetts, some fifteen or twenty years ago, quite a number of analyses of the air from passenger cars were made by Professor Ripley Nichols, of the Massachusetts Institute of Technology, Boston. Furthermore, not less than fifteen years ago a number of analyses of air from the cars of the Pennsylvania Railroad were made, and in 1893 or 1894 a committee of the Master Car Builders' Association made a long report on car ventilation, accompanying that report with analyses of air from Pullman cars, together with the analyses of air from other cars of passenger equipment. Still further, the records of the Patent Office show a very large number of devices which have been suggested from time to time by inventors for accomplishing this desirable end. It should not be overlooked that most passenger cars have some appliances by which fresh air is introduced, or an approximation at least toward a system of ventilation. Some of these are apparently inefficient and poor, and some are better, so that the subject has certainly not entirely escaped attention. In addition to what has preceded it may be stated that for not less than ten years past very careful and systematic study has been put on this problem by the experts of the Pennsylvania Railroad Company, and while it is not proposed in this article to show completely what has been accomplished, it is fair to say that very great encouragement has been met with, and that the outlook for a successful system of car ventilation seems to be very promising.

The first step in the study of any problem is naturally to know what the present state of affairs is. This, so far as car ventilation is concerned, may be briefly stated as follows: Assuming that ventilation means change of air, and that what is desired is to get sufficient fresh air into a car and to remove the foul air, the analyses above referred to indicate that the ordinary passenger coach and Pullman car get from one-sixth to one-tenth as much air per hour through them as is required for good ventilation. There is a fairly close agreement between the analyses from all the sources mentioned above, so that we may, perhaps, be entitled to conclude that a very much larger amount of air than is at present obtained, is requisite for good ventilation in passenger cars.

Perhaps we shall best make clear what follows by asking a series of questions bearing on this subject, and answering these questions to the best of our ability. But before doing this it may not be too much to say that no problem in engineering has, in our judgment, ever been undertaken which is so fraught with difficulties as the ventilation of passenger cars on railroads. A few words will make this point clear.

An ordinary passenger coach contains about 4,000 cu. ft. of space. It is proposed to take into this space sixty persons, to keep them in this space continuously without allowing them a chance to get out, for from four to six hours at a time, to keep these persons warm enough for their comfort in winter and to supply them with the proper amount of fresh air, and at the same time to exclude objectionable material, such as smoke, cinders and dust from them. Certainly here are difficulties enough. The shape of the car itself, being long and narrow, the very small space compared with the large number of people, the question of keeping the people warm, and the exclusion of objectionable matter from them—each one of these items is a problem in itself, sufficiently difficult to tax the skill of the best experts, and when all are combined in one it is little wonder, apparently, that progress has been so slow.

The first question which we will consider is: Is it necessary to ventilate cars both winter and summer? It would naturally be expected that the doors and windows would be sufficiently satisfactory sources of fresh air in the summer season, and that, therefore, it would only be necessary to study the subject of car ventilation for the winter. Unfortunately part of the problem, as already stated, is to exclude objectionable material from without and on dusty roads, it is absolutely essential, even in warm weather, to keep the doors and windows closed on account of dust. Furthermore, smoke and cinders from the locomotive not infrequently are annoying even in the summer season, so that it seems fairly probable that a good system of ventilation should be operative both in winter and in summer, and in the studies above referred to in connection with the Pennsylvania Railroad, this phase of the case has been constantly in mind.

The next question is: Is it possible to have a ventilation system apart from the heating system? It has been urged in the technical press, and in conversation with would-be experts, that it is an easy matter to ventilate cars: simply let air in, and provide places for the foul air to get out. We are compelled to say that we think this is a very unsatisfactory view of the case. In this climate it is simply impossible to let fresh air into the cars in the winter season without warming it, and, consequently, it is perfectly clear that studies on ventilation must at the same time take into account the heating system of the car. Some systems of car ventilation, if they may be called systems, are little more than apertures in the car, and some so-called systems simply attempt to exhaust air from the car, without providing inlets. So far as our knowledge goes, the experience with these systems is that neither of them can be used for any length of time. One can stand a little cold air for a few minutes, but as will be seen a little later, when we come to consider the amount of air required, it is a little short of an absurdity to attempt to ventilate a car without at the same time warming the air.

Just at this point a very interesting question comes in, namely: Is there any means by which we may know when a car is well ventilated or not, and if so what is this means? Upon this point it is fair to say that there does not seem to be agreement among the experts, and it is possible that as time progresses and our knowledge increases, the rule which is given below

may not be adhered to, but at the present time the following is accepted as the measure of good ventilation. A space, be it a car, a room, or a theatre, or whatever may be which is chosen, is said to be well ventilated when a person coming into this space from the outside fresh air detects none of the odor characteristic of a badly ventilated space. Unfortunately, we have no means of measuring odors, but there is one of the accompaniments of the odor which is characteristic of badly ventilated spaces that is easily measured.

Let us see if this can be made clear. Three things are continually given off from our bodies, namely, carbonic acid, water vapor and organic matter. Every time we breathe, we breathe out some carbonic acid, we breathe out some water vapor, as everyone knows who has been out on a cold morning; and we also breathe out, or there is exhaled from our bodies, a certain substance, which, for want of a better name, is simply called organic matter, and which is believed to be the source of the odor. Of these three substances, carbonic acid is easily measurable, and it is customary to take the amount of carbonic acid in the air as the measure of good ventilation.

Many years ago, before this latest test already mentioned was introduced, it was customary to place an arbitrary limit on the amount of carbonic acid that should be allowed in the air in spaces which were said to be well ventilated. That is to say, twenty years ago, if the amount of carbonic acid in the air in any given space did not exceed 10 cu. ft. in 10,000 of the air, that space was said to be well ventilated; but later studies have changed this view. A very large number of analyses of air have been made to find the amount of carbonic acid that is characteristic of the air when you can just begin to detect an odor. In Parkes' "Practical Hygiene" there is given a summary of a very large number of such analyses, giving the amount of carbonic acid that is in the air, when one can just begin to detect an odor. The average of these analyses indicates that when two parts, or 2 cu. ft. of carbonic acid that comes from our bodies, or the bodies of animals, in 10,000 of air is found, one can just begin to detect an odor in a closed inhabited space. Therefore, two cubic feet of carbonic acid given off by human beings or animals in a closed space, in 10,000 cu. ft. of air, is taken as the test or measure of good ventilation. It should be said for information, perhaps, that the air in different parts of the world, and from many different places, has been analyzed a good many times for carbonic acid. From these it is found that there is a certain normal amount of carbonic acid in almost any air. The air in any room, even if the windows were wide open and the room vacant, would contain a small amount of carbonic acid. The averages of these analyses—they vary somewhat, in towns the amount is larger than in the country—is about 4 cu. ft. in 10,000; that is, 10,000 cu. ft. of air contains normally 4 cu. ft. of carbonic acid. If we add to that the two that come from our bodies we would find in a well ventilated space an amount of carbonic acid not exceeding 6 cu. ft. in 10,000. The various analyses referred to in the early part of this article show carbonic acid varying from about 15 to 25 parts per 10,000 in the air of cars. If we deduct the four parts which are characteristic of normal air, this leaves from 11 to 21 parts per 10,000 furnished by the passengers, and since good ventilation, as already stated, should only show an increase of carbonic acid of two parts in 10,000 over the normal, it is evident that, as already stated, the passenger and Pullman cars of the country are apparently getting approximately from one-sixth to one-tenth the amount of air that is required for good ventilation.

The point which we are leading up to, and which we will discuss in the next paragraph is: How much air is actually required per car per hour in order to give satisfactory ventilation? Before taking up this question, however, there is another question that must be discussed, and that is: How much carbonic acid do human beings give off per person per hour? A good many experiments have been made on this point by different investigators. It is found, if we are right, that men give off more than women, and children less than either, and that a man at vigorous work gives off more than a man in idleness. The studies show, so it is stated, at least in Parkes' "Practical Hygiene," that the average of a mixed community, men, women and children, as they occur, give off 6/10 of a cubic foot of carbonic acid per person per hour, part of this coming from the lungs and part from the skin. Since the people traveling on cars may be fairly regarded we think, as representing a mixed community, that is to say, men, women and children, it will, perhaps, be safe for us in our calculations to use this figure, 6/10 of a cubic foot of carbonic acid per person per hour.

This brings us to the discussion of the question just previously stated, namely: How much air per car per hour is needed to properly ventilate a car? It is apparent that if each person gives off 6/10 of a cubic foot of carbonic acid per hour, and there are 60 people in the car, there would be generated or given off in the car per hour, 36 cu. ft. of carbonic acid. The problem then becomes: How much air is it essential to mix with these 36 ft. of carbonic acid in order that the resulting mixture shall contain 2 cu. ft. of carbonic acid in 10,000 of the mixture in addition to the 4 cu. ft. which are characteristic of the normal air? This is a very simple proportion, namely, if 10,000 cu. ft. contain 2, how many thousand cubic feet will be required to contain 36 cu. ft. on the same ratio? Making the calculation and we reach the astounding figure that in order to have a passenger car well ventilated, in accordance with the tests and data that have already been given, it actually requires that 180,000 cu. ft. of fresh air per hour should be taken through the car. We fancy most railroad operating officials, as well as the general public, who have not given the subject careful consideration, will be astonished at this figure. It actually means that the air in a car must be changed about 45 times an hour or once in about 80 seconds.

It is fair to say that in the best information which we can get hold of on ventilation, this is the figure adopted, namely, 3,000 cu. ft. of fresh air per person per hour are requisite for good ventilation of closed spaces. In other words, the best authorities that we can consult on the subject lead up to this figure. Two points, however, may be mentioned as possibly modifying these requirements. First, some studies were conducted a few years ago in Washington, the results of which were published by the Smithsonian Institution, the object of which among other things was to find out to what the drowsy feeling that we have noticed when in ill-ventilated places was due. These studies did not reach any definite conclusion as we read them, but seem to point to the conclusion that 3,000 cu. ft. of air per person per hour was a large figure. The authors of the paper were, however, very cautious, and while their studies did not succeed in isolating any poisons given off from the bodies of human beings that would produce drowsiness, and possibly more serious consequences, they finally say in so many words that their experiments do not entitle them to change the ordinarily accepted figure.

Other points bearing on this question are the experiments made with the human calorimeter, in connection with the Middletown University, by Professor Atwater. In conversation with him on the experiments made with this calorimeter, it was stated that there seemed to be no complaint from the inmates of the calorimeter, due to an increase in the amount of carbonic acid. The analyses of the air taken out of the calorimeter might indicate very much larger amounts of carbonic acid than any figures given above show, and yet the inmates did not complain of drowsiness or of any unpleasant feeling. If, however, the amount of moisture in the air got much above the normal, drowsiness and unpleasant feelings, with occasional headache, seemed to result. With the present state of our knowledge, the best that can be said is perhaps that the question as to the absolute amount of air required for good ventilation is in a moderately uncertain condition, and that there is

need for much more definite work on the subject than has yet been done. For information it may be stated that so high a figure as 180,000 cu. ft. of air per car per hour has not been attempted in the experiments referred to above on the Pennsylvania Railroad. To get such an amount of air as this through a car per hour, and to warm it in severe weather, is a more difficult problem than we have ever attempted to solve. The experiments on the Pennsylvania Railroad have been confined to at attempt to get 60,000 cu. ft. of air per car per hour, or 1,000 cu. ft. of fresh air per person per hour through the car.

Questions in regard to the amount of heat and heating surfaces required to heat 60,000 cu. ft. of air per car per hour, questions in regard to the appliances made use of in accomplishing the results thus far obtained, questions in regard to the details of the experiments, questions in regard to the exclusion of objectionable matter from without, the method of obtaining control of the system, the analyses of the air from cars, with and without the system, etc., will have to be deferred to another article. Two points farther may perhaps be reasonably touched upon in this article.

The first of these has a bearing on the attempts made so often by those who have not apparently sufficiently studied the problem, to get ventilation by putting on ventilators. In one of our experiments as many as 20 Globe ventilators were put on the deck of a car, proper appliances having been made use of, as was supposed, to admit sufficient air to the car. It was found as the result of these experiments that the ventilators on the front end of the car, especially when the wind was ahead, acted so vigorously in producing a vacuum in the car that actually the Globe ventilators on the rear portion of the car took in air instead of exhausting it, as it would naturally be supposed they would do. In other words, this experiment, we think, most conclusively proves that there must be a proper relation between the supply of air and the exhaustion of air. It may be worth mentioning that the peculiarity found when the car was running was that the rear of the car was a great deal colder than the front end, and in the attempt to find why this was so, the point mentioned above, of the cold air coming in through the Globe ventilators in the rear of the car was developed. We are very firmly convinced that exhaustion of air from any space is not ventilation. There must be fresh air supplied as well as the removal of all polluted air from the space that it is sought to ventilate.

One question further: How is it possible to measure the amount of air that goes into and out of a car per hour? We have already spoken about the enormous amount of air required, according to present ideas, for successful ventilation, and also that the attempt had been made in the experiments on the Pennsylvania Railroad to get 60,000 cu. ft. of air required through the car, but how do we know, or what means is there for telling whether we get 60,000 or 40,000 or 100,000 cu. ft. of air per car per hour through the car? This problem is not so simple as it looks. Obviously, with the leakages and the friction of the air in the ventilators, any attempt to measure the amount of air by taking the velocity of the current issuing from the Globe ventilators would be fallacious. The air issues not only from the Globe ventilators which are put on for the purpose, but also from the ventilators over the lamps. Furthermore, any attempt to measure the velocity of the current from the intakes would probably result in failure, owing to the fact that around doors and windows there are constant leakages; so it is obvious that some means of measuring the air other than by taking the sizes of the apertures and velocities through these apertures must be made use of.

The data already mentioned, we think, gives us a means of getting at what we are seeking. It has already been stated that the average of a mixed community gives off 6/10 of a cubic foot of carbonic acid per person per hour. If now we have a definite number of people in the car, and can safely assume that on the average a certain amount of carbonic acid is given off per person per hour, it is obvious that we can very readily calculate how much carbonic acid per hour we have to deal with; and this being known, a very simple calculation, as already shown above, will give the amount of air required to dilute this to any given figure. What was actually done in our experiments was, the cars were loaded with men from the shops, in charge of a foreman, so that the doors and windows could be kept closed, and a trip of 30 or 40 miles made. Toward the end of the run, samples of the air in the car were taken, which were analyzed for carbonic acid. If, for example, it was found that the amount of carbonic acid in the sample showed 11 parts in 10,000, we have the data to calculate how much air passes through the car per hour, as follows: It has already been stated that the air normally contains four parts of carbonic acid in 10,000. If we diminish the 11 by 4, it is obvious we have 7 parts of carbonic acid per 10,000 of air as given off from the passengers. There being, say, 60 men in the car, and since they are full grown laboring men, the amount of carbonic acid given off being stated by the authorities as somewhat higher than the average of a mixed community, say 0.72 cu. ft. per person per hour, instead of 0.60 cu. ft., it is obvious that we have 43.20 cu. ft. ($60 \times 0.72 = 43.20$) of carbonic acid to deal with, and our problem really is, How many cubic feet of air are required, in order to dilute 43.20 cu. ft., so that the amount will be 7 parts in 10,000 of the air? Now, by a very simple proportion, if 10,000 cu. ft. of air contain 7 parts of carbonic acid given off by the passengers, how many thousand cubic feet of air will be required to dilute 43.20 cu. ft. to the same ratio? Making the calculation, we get, under the conditions supposed, a trifle over 61,700 cu. ft. It will be understood that in this calculation extreme accuracy to the amount of a few cubic feet is not aimed at, and also that since the cubic feet of space in a car is so small, and the air in the car changed so frequently, the amount of air in the car to start with has been ignored.

It is, perhaps, not premature to say that the system worked out on the Pennsylvania Railroad has been in use on five cars for considerably over a year. It may be too soon to speak positively farther in regard to the success of the system, and it is possible that additional experimentation will be needed before it can be called satisfactory. It is not too much to say, however, that the outlook is hopeful.

Mr. R. H. Soule, Member A. S. M. E., recently resigned as Western Representative of the Baldwin Locomotive Works, and has opened an office at 71 Broadway, New York, as Consulting and Designing Engineer. He will make a specialty of plans and specifications for locomotives, cars, shops, machinery, power plants, mechanical and electrical equipment, investigations and reports, also appraisals and valuations. We know of no one better able to bring so varied and extensive an experience to bear upon such questions, and doubtless many railroad officers will be glad to avail themselves of his opinions and advice. Mr. Soule is splendidly equipped for the greatest motive power responsibilities, and while no single corporation will now enjoy his exclusive attention, his work will remain in the line of transportation subjects, but his field is widened. He graduated from Harvard College in 1870, and from the Massachusetts Institute of Technology in 1872. After spending two and a half years in machine shops, such as the Southwark Foundry, Philadelphia, he entered railroad service in the Mechanical Engineer's office of the Pennsylvania. After passing through the grades of Signal Engineer and Assistant Engineer of Tests, he was made Superintendent of Motive Power, successively, at Baltimore, Williamsport and Columbus, Ohio. After that he served two and a half years as Superintendent of Motive Power of the West Shore, then for one and a half years in the same capacity on the Erie, and held the position of General Manager of the Erie for one year. Following this he was General Agent for the Union Switch and Signal Company, and for six years was Superintendent of Motive Power of the Norfolk & Western. For the past two and a half years he has represented the Baldwin Locomotive Works in Chicago.

We are informed by Mr. J. H. Hadley, President of the International Power Company, that Mr. Joseph Lithgoe, Superintendent of the Locomotive Works at Providence, R. I., has not resigned as has been stated.

REPAIRS TO STEEL FREIGHT CARS.

By C. A. Seley,

Mechanical Engineer, Norfolk & Western Railway.

The ordinary facilities for freight car repairs, as found on most railroads, may be summed up as follows: an arrangement of tracks more or less conveniently located for receiving bad order cars, and discharging them when repaired; a small store of standard material; a smith shop and a supply of tools, wrenches, jacks, etc., and a small paint outfit. The class of labor employed is somewhat higher in grade than common labor, although more largely recruited from that class than from the trades. The ordinary repairs of wooden cars may be cheaply and expeditiously handled under an arrangement, such as above described, although one of the Western roads whose shops and methods have been recently extensively written up in the railway press, has arranged to bring the cars to the men and material instead of distributing the men and material to the cars.

Whatever the arrangement of facilities for ordinary repairs, the problem of how best to arrange for the repairs of the large capacity car which has come to stay as a factor in modern traffic remains to be solved. Many of these are built entirely of steel, some with metal underframing and wooden bodies or hoppers, and the all-steel truck is common to these and to a large proportion of the 60,000-pound cars of to-day.

It goes without discussion that a disabled steel car or truck cannot be either cheaply or expeditiously repaired with the ordinary facilities. The result is that the broken or bent parts to be repaired, whether rolled or pressed sections, are laboriously transported to the main shops for the attention of blacksmiths or boilermakers, for cutting apart, repairing and re-riveting. These parts are also laboriously transported back again after treatment by relatively high-priced labor, and in course of time, and generally a long time, the car is completed and returned to service. It is not that the time to actually do the work is so long, but the conveniences, the system and the facilities for this class of work have not as a rule been provided on many railroads. There is no reason why the class of labor now employed in wooden car repairs cannot be trained to do most of the work required in repairs of these heavier cars, if suitable facilities and supervision were provided. It is not here contended that it is right to invade the domain of the trades, but to show that car repairers, many of whom have not served an apprenticeship as carpenters and yet wield saw and hammer, could be trained to handle a sledge and chisel bar or drive a rivet in strictly car repair work.

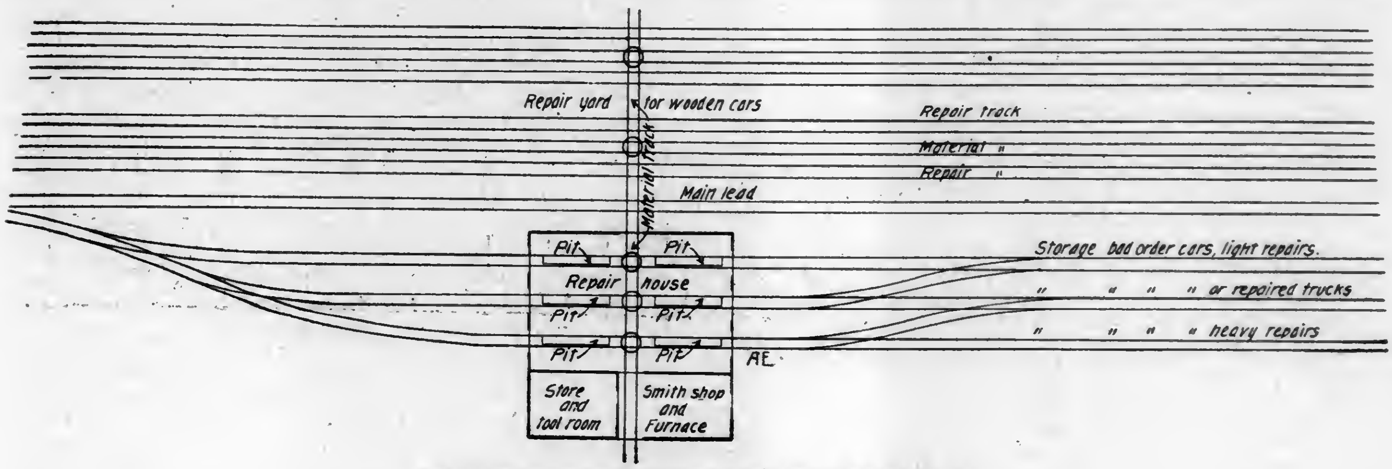
As a rule, the boilermaker prefers to work on boilers and tanks, and bridge or car work is an aggravation when brought to his shop. He feels that he is doing other people's work. A blacksmith would rather, ten times over, make new arch bars and truss rods than straighten and repair old ones. This is a phase of human nature which must bend and adapt itself to the force of circumstances, but is mentioned in order to show the opportunity for the car repairer, who sometimes thinks, when a lot of steel cars comes on the repair track, that his day is nearly over. To keep this work out of the shops and have it done at the repair tracks where it belongs, and save the time and expense of extra handling, it is necessary to provide the repair track with the facilities and arrange them to do the work on a new plan. In the first place, it is necessary to bring the car to the tools, the fires, and the men; and in order that these may be used to advantage, cared for and be available in all seasons, a shop or at least a partially inclosed structure is a necessity, preferably a long one with two or more tracks with working space between them and on the sides. One track is to be used for repairs of all steel trucks of steel cars, or cars whose bodies may be of wood and repaired elsewhere. The other tracks are for all-steel or steel frame cars, and all tracks should be connected with each other and with the main lead of the yard system, to facilitate movements.

Frequently a bent metal end sill or a sprung side sill or stake, or perhaps a bent brake stirrup or step may be straightened without removal from the car, provided heat may be applied. Here is an opportunity for a portable furnace and a temporary arrangement of fire brick to concentrate the heat, and a jack or sledge, or perhaps a simple lever, will often do the rest. A gasoline torch will often provide necessary heat and can be applied to what may be otherwise inaccessible locations. With none of these appliances it will very often cost a great deal, comparatively, to cut the defective member off out in the yard, take it to the shop for treatment and get it back again. A great deal of straightening of plates can be done by a hook, a chain and a turnbuckle. Some of these jobs are so small that the cost of doing them is out of all proportion to their importance, yet they must be done. The car repairer, accustomed to bolts and nuts and nails, is helpless before a simple rivet, merely because he has not the appliances for handling them. Riveted parts requiring removal for renewal or straightening can be quickly cut loose with a chisel bar and sledge or a pneumatic nipper.

An excellent adjunct for heating channels and other rolled sections, now so extensively used in trucks and body bolsters, is an oil furnace, long enough to take in the entire length. With a good face plate these pieces can be straightened, generally in one heat. An oil furnace is quickly made available for use and quickly extinguished, and it can be used for arch bars, bent rods and plate work also. An ordinary forge is also necessary; and in many situations the entire smithing for the yard could be concentrated in connection with this work. The stock of tools, drills, etc., must be governed by circumstances and in accordance with the class of cars and number to be handled. The supervision of such a shop should be in the hands of a man, skilled in handling, heating and working of metals, but the major portion of the help required may be recruited from the ranks of the car repairers and trained for this class of work just as men must be trained for wooden car repairs.

It must be borne in mind that time is the most important factor in this calculation. The large cars must be kept in service to handle traffic. They are expensive in first cost and displace two or three of their smaller brethren, and it is a false idea of economy to buy these cars and then provide a hand chisel, a ratchet drill and a portable rivet forge with which to make repairs, when, by taking advantage of the rapid working tools and methods, much time can be saved and the car quickly returned to service. It costs about the same amount per hour to operate a ratchet drill as it does an air drill, but the one will make about six revolutions per minute to one hundred and sixty of the other. Note the difference in the execution with the same rate of feed per revolution. The same thing applies to hand as compared with machine riveting on structural work of all kinds.

The above described shop should be supplied with compressed air to operate air drills, nippers and riveters, blow the fires, test the brakes, operate jacks and lifts. We find all these things in the best locomotive repair shops, and they are necessary for handling parts and for doing work in such a way as not only to bring the cost down, but save time. It is important to get the engines back to service, and why not use the same labor and time-saving appliances and methods in doing the work to get the large cars back to service? Heretofore the engine and the car were of different materials, one of iron and the other of wood, requiring the services of two different sets of men and different kinds of supervision for their care. Now that the car is largely of the same material as the engine, its repairs, in order to be consistent, should be undertaken on similar lines as to appliances, and a system



A Suggestion for Facilities for Repairing Steel Cars.

of labor should be developed to permit the best use of these appliances.

It may be asked, what such an outfit would cost. It may be replied that any road contemplating such a scheme will have to fit it to their needs and equipment. No two roads are exactly alike in these particulars, and as this is a new thing, designed to meet a condition that has but recently arisen, the details will differ as handled by the different interests. Some roads would be wise to extend the scheme, and fit up the shop to take in all work on rolled structural material entering into railway equipment, such as bridge work repairs, steel tender frames and the like. As outlined, however, the arrangement is applicable to most roads and can be worked in without difficulty as to details.

A plan embodying some of the ideas set forth is herewith presented, merely as a suggestion, to be modified as may seem necessary to fit it in with existing repair yards. A repair house is shown, so located with reference to the general repair yards as to serve also as an adjunct or auxiliary in supply and repair service. The stores and the smithing for the entire yards are here concentrated, the store clerk also having charge and care of tools, which for steel car work represents considerable value and outlay on the part of the railway company.

Many of the tools used in the repair of wooden cars are the ordinary tools of the car repairer and owned by them, the railway company furnishing wrenches, cold chisels, sledges and the like. The ownership of tools for repairs of steel cars, however, will necessarily be almost entirely with the company, and a good argument for the repair house is on the ground that the necessary tools can only be used to advantage, cared for and kept track of in a house, and not when scattered over an outside system of tracks.

Communication and transfer of material between the house and yards is established by a track running through the smith shop and repair house and across the yard. Push car tracks are laid between alternate pairs of repair tracks and turntables are used at the intersections with the cross track. By these means materials can be taken to any portion of the yard. These tracks should be standard gauge so that car trucks may be transferred to them and run to the repair house when their repairs can be better undertaken there, while the body, if of wood, may remain in the yard for its repair.

The repair house as shown has three tracks, each with two shallow pits which will be found to be more convenient than a level floor. The pits are each to be supplied with air connections and hose for operating pneumatic tools, testing brakes, etc. Overhead handling apparatus will be found more convenient than any other, preferably light hand traveling cranes over each pit or section. These are of short span and may be made of an I-beam on traveling wheels, the runways being supported by the roof trusses or posts. A trolley running on the lower flanges of the I-beam and carrying a triplex or other multiple speed chain blocks will be found superior to an air hoist for the variable work the hoists may perform. A gantry crane with a top cross rod and brace of sufficient height to clear the cars and to run on rails outside of the regular tracks may be preferred by some and are perhaps cheaper than the overhead cranes, but do not approach them for general convenience and utility. Overhead handling appliances might be spared over the section devoted to light repairs, as the occasional rivet here or there to be driven can be done by hand or, better yet, by a long stroke air hammer, a very efficient tool which can be handled almost anywhere and needing no supporting apparatus save the arms of a sturdy operator. For extensive and continuous riveting in rebuilding or new work, the overhead handling is necessary for the heavier air riveters of the yoke pattern, of which several styles are available.

As before stated, many cars are to be shopped for comparatively slight repairs, and yet the ordinary repair facilities do not cover them. For this reason the plan shows that the cars for light repairs can enter the house on either of two tracks, although the center track is intended mainly for truck repairing. It may so happen that a road may have a line of large cars with poor trucks and good bodies or, to state it in other words, the truck repairs may exceed the body repairs. In such a case the truck repair track, if properly organized, can turn out and store trucks so that by a change of trucks a car may be returned to service without the delay of waiting for the repair of its own particular trucks other than the wheels and axles, which, on account of records, must stay with the car.

A car coming in for heavy repairs would be placed over a pit, the air brakes disconnected and the car raised by air jacks so that the trucks could be run out and transferred to the truck repair track. It is then lowered upon blocking or horses and the defective parts removed.

It is believed that a shop as here outlined, be it an elaborate structure or a partly inclosed one, can with good organization turn out repairs well and cheaply. It is a distinct departure from present methods, but present methods are entirely inadequate and the plan is offered in the belief that the time has arrived when many roads must face the situation brought about by the use of steel in car construction.

Mr. H. Rolfe, of the International Correspondence Schools, of Scranton, presented an able and interesting paper upon bearings at the May meeting of the New York Railroad Club. Written from the standpoint of the designer and fitter, it gave a treatment of the subject which was unusual and exceedingly valuable. We shall refer to it again.

Mr. Edward Grafstrom has been appointed Mechanical Engineer of the Atchison, Topeka & Santa Fe. He was formerly Mechanical Engineer of the Pennsylvania lines west of Pittsburg, under Mr. S. P. Bush, and subsequently Mechanical Engineer of the Illinois Central, which position he leaves to accept his new appointment.

COMPARATIVE PERFORMANCE OF HEAVY AND MEDIUM WEIGHT LOCOMOTIVES.

Mountain Pushing Service.

Lehigh Valley Railroad.

By F. F. Gaines, Mechanical Engineer Lehigh Valley Railroad.

This piece of track on the mountain cut-off, Wyoming Division, on the Lehigh Valley Railroad, as shown by Fig. 1, for 19½ miles has a grade of about 60 ft. to the mile, with frequent curves of 8 degrees. The remaining four miles has a grade of 16 ft. to the mile only, but with a full train it is necessary for the pusher to follow until the summit is passed. The principal dimensions of the former pusher engines are shown in Fig. 3, as engine No. 695, and the present pushers as engine No. 1,300, Fig. 2. Both have wide fireboxes and burn a mixture of bituminous and buckwheat anthracite. Engines of the 695 class can push, on the average, about 600 tons, and engines of the 1,300 class can push about 1,000 tons.

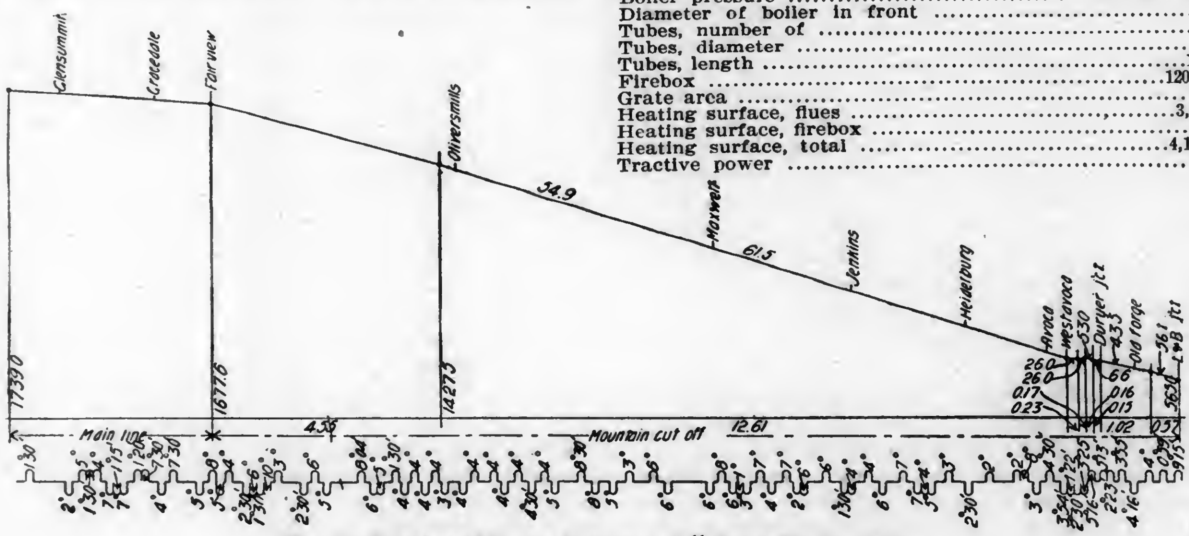


Fig. 1.—Grade and Curve Diagram of "Mountain Cut-Off."

The accompanying table covers the performance of engines 1,300-1,310 for December, 1899, January, February and March, 1900; and engines 687-699 for a period of six months in the fall and winter of 1898.

Taking the total costs per ton-mile, it will be seen that there is an economy of 23.66 per cent. in favor of the new engines. There is also considerable indirect economy to the company in the fewer trains run and the greater volume of business that can be handled when traffic is heavy. That the latter is no inconsiderable item will be realized when it is known that all through freight, east bound, must pass over this hill:

PERFORMANCE SHEET.

Engines	1301-1310 Inclusive.	687-699 Inclusive.
Time for comparison	Av of 4 mos.	Av. of 6 mos.
Total mileage	1,757.25	2,716
Tonnage hauled (tons, 2000 lbs.	33,543.875	26,690
Distance hauled (miles)	23.5	23.5
Ton mileage	788,296	627,115
Coal used (short tons)	286.909	215.614
Cost of coal used	$221.95	$179.908
Cost per ton-mile	.00028155	.00028688
Cost of all oils used	16.567	13.874
Cost of oils used per ton-mile	.0000211417	.000022123
Cost of water supply	4.33725	3.72
Cost per ton-mile	.000005553	.000005932
Waste and other supplies	11.33175	13.580
Cost per ton-mile	.000014495	.000021655
Cost enginemen and firemen	196.2475	234.9
Cost per ton-mile	.0002476	.0003745
Roundhouse men	24.09775	27.2958
Cost per ton-mile	.000030689	.00004352
Repairs	222.35975	178.077
Cost per ton-mile	.00028207	.0002838
Interest and depreciation	157.50	135.42
Cost per ton-mile	.000200935	.00021594
Wages of train crew	201.8952	314.3502
Cost per ton-mile	.00025612	.00050113
Total cost per ton-mile	.001340154	.00175548

This brief description by Mr. Gaines and these interesting figures represent a careful analysis of the work done by engines of the consolidation type as to wheel arrangement, but differing as to weight. Engines Nos. 1,301 to 1,310, inclusive, were illustrated in our issue of December, 1898, page 395. They are

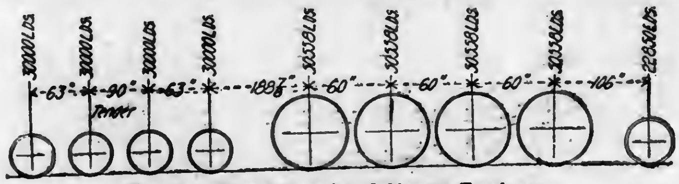


Fig. 2.—Wheel Loads of Heavy Engines.

Vauclain compounds, having a total weight of 225,082 lbs., distributed as indicated in Fig. 2. The following table gives the chief characteristics of this engine:

Diameter of drivers over tires	55 in.
High pressure cylinders	18 by 30 in.
Low pressure cylinders	30 by 30 in.
Valves	Balanced piston type
Boiler pressure	200 lbs.
Diameter of boiler in front	80 in.
Tubes, number of	511
Tubes, diameter	2 in.
Tubes, length	14 ft. 7¾ in.
Firebox	120 by 108 in.
Grate area	90 sq. ft.
Heating surface, flues	3,890.6 sq. ft.
Heating surface, firebox	215 sq. ft.
Heating surface, total	4,105.6 sq ft.
Tractive power	48,403 lbs.

The other engines, numbered 687 to 691, inclusive, are also of the consolidation type, having a total weight of 150,500 lbs., distributed as indicated in Fig. 3. The following table gives their chief dimensions:

Diameter of drivers over tires	50 in.
Cylinders	22 by 28 in.
Valves,	Richardson balanced
Boiler pressure	160 lbs.
Diameter of boiler in front	72 in.
Tubes, number of	338
Tubes, diameter	2 in.
Tubes, length	14 ft. 3½ in.
Firebox	113¾ by 96 in.
Grate area	75 8/10 sq. ft.
Heating surface, flues	2,514.53 sq. ft.
Heating surface, firebox	107.3 sq. ft.
Heating surface, total	2,621.83 sq. ft.
Tractive power	31,176 lbs.

The tenders for both engines are alike in capacity and weight.

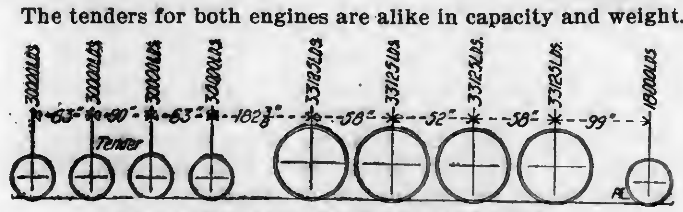


Fig. 3.—Wheel Loads of Lighter Engines.

They carry 7,000 gals. of water, 18,000 lbs. of coal, and weigh 120,000 lbs. each.

It will be noted from Fig. 1 that this is an extremely difficult piece of track, having 60-ft. grades and eight-degree curves. There are 85 curves in 19½ miles, as shown in Fig. 1. The tabulation by Mr. Gaines is exceedingly interesting and instructive in comparing these two engines of widely differing weights and capacities, and the results as noted above show an advantage of nearly 24 per cent. in this extremely difficult ser-

vice. The combined advantages of compounding and higher steam pressure with greater capacity are shown in the first table. The figures given by Mr. Gaines are carried out to a large number of decimal places, showing the care taken in the calculations. His suggestion that there is additional economy in the smaller number of trains to handle a given tonnage with the heavy engines is an important one. This is, in fact, the most important item of saving, since the capacities of the two engines are as 10 to 6. The saving in total cost per ton-mile is remarkable evidence in favor of modern improvements. The heavy engines in this comparison are remarkable for their power, particularly that of the boilers.

THE NEED FOR FURTHER TESTS ON LOCOMOTIVE EXHAUST ARRANGEMENTS.

By H. H. Vaughan.

Four years have passed since the report of the committee on exhaust pipes and steam passages was presented to the Master Mechanics' Association, which have been years in which this subject has dropped out of sight at the conventions, while recommendations then made have been put into practical service and tested under conditions that have led in the majority of instances to their indorsement as substantially correct. There are yet, however, many roads whose practice differs considerably from that recommended, and it is well to remember that the tests, exhaustive as they were, and entirely satisfactory as far as they went, did not complete the investigation of the subject, which, it was then shown, could only be successfully attacked by the method used, namely, experiments carefully carried out on a stationary testing plant.

So far as the best location for the exhaust pipe and its relation to the stack are concerned, there is little reason for reopening the matter, as these points were most satisfactorily and thoroughly settled, but any reader of the report cannot fail to be struck by the statement with which the results of the experiments on single nozzles are closed: "A test with petticoat pipe and exhaust pipe, as used in road conditions, shows a better efficiency than any of the experimental arrangements, and a decided improvement over the test made with the petticoat pipe removed entirely." It is the introduction of this additional factor, the familiar petticoat pipe, that has figured in every conceivable form in locomotives for the last thirty years, that renders these tests incomplete and prevents their being accepted as demonstrating the final and accurate method of designing a front-end arrangement. Assume, and there is very little risk in doing so, that the form of nozzle, shape of stack, and location of exhaust pipe shown most desirable in these tests is truly so for an engine without the petticoat pipe, and there is still not an iota of evidence to show that they are so when that pipe is added.

In the committee tests the most advantageous arrangement without a petticoat pipe was ascertained, and with this arrangement several different forms of petticoat pipe were tested. The road arrangement was then tried and found preferable to others. This of itself is practically proof of two facts; first, that the best position of the exhaust nozzle, when used without a petticoat pipe, is not the best when used with one; and second, that a petticoat pipe affords the means of obtaining a more efficient draft arrangement than can be obtained without it. These statements may be questioned, but they accord with general service experience, and, if correct, show that but part of the work has been accomplished, and there is need for a continuation of the experiments in order to settle the best exhaust arrangements for draft producing purposes.

There is a good deal of evidence to show that if such experiments were made, the best position of the nozzle might be found to be considerably different from that in which no petticoat pipe is employed, and there is the added possibility that in such a case the change might lead to a more efficient design of front end, a question that is, to a certain extent, dependent on it.

While the front end and the draft producing apparatus must necessarily be considered as a whole, it is well to remember that they are, to a certain extent, independent. The nozzle and stack may be exceedingly efficient as draft producers, but combined with a poorly designed front end, or one out of order, this efficiency may be of no avail. It is reasoning from rather slight evidence to state that the deflector plate so commonly employed is an objectionable article, and yet the reason for its employment, if looked into, is inconsistent. The nozzle, in the position in which it is generally placed, causes the greatest vacuum or flow of air above the center of the boiler. The consequence of omitting the deflector plate would be that the upper flues would have the greater draft and the lower flues not enough. In order, therefore, to equalize matters, the deflector plate is introduced, which, by means of obstructing the draft to the upper flues, equalizes it over the flue sheet and overcomes the trouble. In other words, having, at the expense of back pressure in the cylinders, obtained the necessary draft, an obstruction is placed to prevent the free flow of the gases through the flues, thus destroying it. Data are wanting on which to correctly estimate the extent of this action, but in some experiments carried out by the Rose Polytechnic Institute on the Louisville & Nashville Railroad, there is an average of 0.9 to 1.0 in. of water difference in vacuum between readings taken above and below the deflector plate or diaphragm, with a total vacuum of 3 to 4 in., and in some readings taken by the writer a difference of ¾ in. was found with a draft of from 2½ to 3 in. As a fair estimate of the amount of power required to obtain 1 in. of vacuum is 2 per cent. of the total power of the engine, such a factor is certainly not negligible, although, for practical purposes, it may be unavoidable.

Now the deflector plate is an accompaniment of the high nozzle and extended front end, and was little used with the older type of low nozzle, with which excellent results were and are obtained. The experience of the Union Pacific Railway with low nozzles, short front ends and diamond stacks is a case in point, and their experience as to the success of the low nozzle is by no means isolated, although it may be ascribed to the use of a short front end. The efficiency of the short front end has, however, always appeared to the writer as being open to question. It is certainly a fact that in the experiments of the Master Mechanics' Association Committee a reduction in vacuum was found when the front end was lengthened, but it was not determined whether, with this reduction, there was any less air pulled through the fire or not, which is the only reason for which a draft appliance is used. In other words, if the longer front end allowed the gases to flow more freely to the stack, and with less obstruction, the air drawn through the fire might be the same, while the vacuum at the nozzle was less. This is, of course, merely a surmise, but as the discussion which Mr. J. Snowden Bell's recent paper developed before the Western Railway Club demonstrated, the best length of front end is hardly a settled question.

To return to the nozzle, the experience of the Philadelphia & Reading is instructive. When the Wootten fireboxes were introduced on this road considerable difficulty was experienced with the draft arrangements, and the result of many experiments was the adoption of the low nozzle with a petticoat pipe extending from about 1 in. above the nozzle to 6 or 7 ins. from the stack. In the last few years many of these engines have been fitted with an exhaust pipe designed in accordance with the recommendations of the Master Mechanics' Association, but with this pipe, while the engines would steam, the size of nozzle required was less than with the low pipe. With the old arrangement no deflector plate is used, the netting being placed vertically in front of the flues and the draft adjusted by changing the distance between the top of the petticoat pipe and the stack. The pipe has been made in two or more sections, but without apparent improvement. This netting ar-

rangement is exceedingly inconvenient for burning soft coal and is practically inadmissible for that purpose, but the greater efficiency of the low nozzle and pipe is worthy of attention. Of course this is not brought forward as a recent discovery, as many roads have no doubt had similar experience, and some probably exactly the opposite, but it raises a point that may be worthy of attention. If the Master Mechanics' tests showed anything conclusively, it was that the action of the exhaust jet depended not on any piston action but on the entraining action of the particles of steam. This entraining action probably grows weaker as the distance from the nozzle increases, and the steam on the edges of the jet loses its velocity. They showed that the form of the nozzle had its influence on the efficiency of the jet, that nozzle which tended to produce the most condensed jet giving the best results. Now it is everyone's experience in viewing a jet, that above about 20 to 30 in. from the nozzle the jet begins to curl on the edges, to break up into waves, and, from this point on, its entraining action must be very small. Is it not possible that the action of the petticoat pipe is to hold the jet together, to keep the steam in contact with the air for a sufficient time to impart the velocity of a greater portion of the jet than just the edges to the air, and thus to utilize a greater proportion of the energy of the jet? Such a supposition appears to accord very well with the experiments of the committee, and, if correct, furnishes a reason for the increased efficiency. The conclusion from such reasoning would be that, given a sufficient length of pipe to impart the velocity of the jet to the air, a greater length would make but little difference, thus enabling the nozzle to be placed in the best position for equalizing the draft without the use of a deflector plate. Another would arise to the effect that as long as the pipe inclosed the jet while its edges possessed considerable velocity, the action would be substantially the same. On the Philadelphia & Reading a front end was applied to test this latter assumption, in which a low nozzle was used with a petticoat pipe placed about 18 in. above it. The netting was in hopper form and extended down to the nozzle. This arrangement, tested both by a vacuum gauge and by the action on the fire in service, gave an almost perfect distribution of draft without the deflector plate, and, like the other experiments, ran with a nozzle about ½ in. larger than any other engine on the division. It was also an advantageous arrangement on account of the gases not being forced through a constricted opening at the bottom of the steam pipes.

Granted that such a discussion as this proves nothing, and can only add one or two more forms to the varied selection that can be seen by inspection of the front-end arrangements of a number of roads, still the fact remains that there is a good deal still to be learned on exhaust arrangements where a petticoat pipe is used, and that nothing in this respect has yet been settled by the admirable experiments of the Master Mechanics' Association. It is to be hoped that a similar investigation may be made on this subject which should complete the work so thoroughly begun.

As disclosed to the Interstate Commerce Commission by reports of its inspector, many roads have been using automatic couplers so out of repair that the cars could not be uncoupled without the trainmen going between the cars, and being, in some cases, obliged to resort to mechanical means to get the cars apart. Such a coupler is not automatic, and its use subjects the men to risks and dangers obviously greater than those which existed when the old link-and-pin coupler was employed. The Commission has called the attention of the railway presidents to the defective condition of automatic coupling attachments in their car equipment.

Mr. A. A. Bradeen, Master Mechanic of the Eastern and Franklin divisions of the Lake Shore & Michigan Southern, has resigned, and the jurisdiction of Mr. S. K. Dickerson, Master Mechanic at Norwalk, O., has been extended over these divisions. Mr. Dickerson's headquarters will be transferred to Cleveland, O., and Mr. T. E. Graham, who has been appointed Assistant Master Mechanic, will have his headquarters at Norwalk.

THE WIDE FIREBOX AS A STANDARD.

By J. Snowden Bell

It is not unfrequently the misfortune of improvers to be so far in advance of the times that the approval and acceptance of their designs in general practice come too late to bring them a more substantial reward than mere fleeting fame. The Forney engine, which was designed about 1865, and the wide firebox, which dates from 1854, will be recognized as prominent instances of the tardy adoption of improvements of undoubted merit and value, and each of these has been delayed, partly through conservatism and force of habit, and partly because its advantages have not been properly and sufficiently urged upon those who would be benefited by them.

The proposition, which is submitted unqualifiedly, that the narrow firebox has outlived its usefulness, and that a wide firebox should be standard in all classes of locomotives will doubtless be considered wholly untenable by many good authorities, and admitted only with considerable limitations by others. It is, however, presented with entire confidence, and in view, not merely of theoretical considerations, but also of the results of extended and successful practice, and if its presentation should, as is hoped, induce a more thorough and intelligent discussion and understanding of the subject matter than has heretofore been made and had, the purpose of the writer will be fully accomplished. To ignore, without consideration, the claims of advantage of the wide firebox, would be inconsistent with the duty of investigating any suggested improvement in his line, not manifestly chimerical or absurd, which would seem to be properly imposed upon every motive power officer, and if these claims are sustainable, their money value to the railroads is much too great for them to be allowed to remain unutilized.

Since the introduction of the wide firebox, ordinarily so-called, in the United States, some twenty-three years ago, it has been applied to, and is to-day successfully used, both in passenger and freight service, on engines of every type, from small four-wheel shifters to the largest and most powerful ten and twelve-wheel engines which have been lately constructed. It has become practically standard on roads using anthracite fuel, and has, within the last few years, been applied for use with bituminous coal, to an extent sufficient to warrant the conclusion that its general introduction will not be long delayed. Under these circumstances, the time seems ripe for thorough consideration of the advisability and economical advantage of its adoption, to the exclusion of the ordinary narrow type, as the standard form under any and all conditions of fuel and service.

The comparatively slow advance of the wide firebox seems to the writer to have been largely due to the fact that sufficient attention has not been given to the subject by officers of roads using bituminous coal exclusively, upon which, of course, the widest field for the utilization of any improvement in locomotive design is presented, as well as to an impression, as general as incorrect, that this type of firebox is advantageously adaptable to use only with anthracite coal, and that it necessarily involves the large increase of grate area and particular form and proportions which have been adopted in engines using that fuel. Builders who have had greater or less experience in the construction of wide firebox engines for anthracite coal have, doubtless, tacitly and unconsciously contributed to support the erroneous view referred to as to the size and proportions of wide fireboxes for bituminous coal, by their adherence to their practice in anthracite engines and their failure to offer any new or special designs for use with bituminous coal. Prior to the construction of the "Prairie" type, and the class G 3 shifting engines, of the Chicago, Burlington & Quincy R. R. (American Engineer, April, 1900, page 103), no attention appears to have been paid to designing a wide firebox specially suited to bituminous coal, and all those

that have been built for use with that fuel have been practically identical with the constructions previously used with anthracite.

The errors above indicated are so obvious that they do not require to be argued against, and their elimination divests the wide firebox from much which has debarred it from favorable, or even impartial, consideration by those using bituminous coal. A discussion, on general principles, of the relative merits of large and small grate areas, to be intelligent must be somewhat extended, and would serve no useful purpose here, even if space permitted. It is, however, plainly the fact that the most recent and the most approved practice, in narrow fireboxes, is in the line of an increase of grate area to the limit permissible under structural and operative conditions. This limit, which is soon reached, is imposed by the maximum distance through which coal can be fired—an uncertain factor—and the distance between the driving wheels—a positive one—and even assuming that an extremely long and narrow firebox can be properly fired, which assumption is not believed to be warranted, the facts remain; first, that sufficient grate area for free steaming with a large exhaust nozzle and economical consumption of fuel, is not obtainable; and, second, that the space within the firebox widely departs from that which mechanical principles prove to be the most advantageous form, i. e., that which approximates a cube. If it be admitted that the grate area of a narrow firebox is sufficient, it will be better adapted to economical combustion of the fuel if it be disposed more nearly in square than in rectangular form, and such preferable disposition of it cannot be had in a narrow firebox. Be this as it may, the disadvantage of insufficient grate area is manifest and unquestioned; that of excessive grate area is problematical and undetermined, and, if it be found to exist in a wide firebox, it can be effectually and inexpensively overcome, not only without injury, but also, as will be shown hereafter, with positive benefit, to the operative efficiency of the firebox.

Upon the assumption, which it is believed is fully warranted by recent practice, that a substantial increase of grate area, obtained either by a wide firebox or by an increase in the length of a narrow one, is, and is recognized to be, effective and valuable in the economical combustion of the fuel and the promotion of free steaming, there would seem to be but one possible ground of denial of the claim that the wide firebox should be standard in all classes of locomotives, i. e., that it is not perfectly adaptable in engines of the American type having driving wheels of the larger diameters, as 80 or 84 in. This objection is not without force, if a considerable depth of firebox be insisted upon, although the design proposed by Mr. Edward Grafstrom, and published in the May issue of this journal, page 136, provides a wide firebox engine of this type, with 80-in. driving wheels, which embodies all the features of advantage of the ordinary narrow firebox engine without any apparent objection due to the employment of a wide firebox. As the design referred to is stated to be offered as a suggestion and open to criticism, it may be in order to suggest that the facilities for burning coal in the firebox instead of pulling a large percentage of it through the tubes, appear so sufficient that the utility of the 18-in. smokebox extension, shown in the side view, is not at all apparent. An extended smokebox is a mere, and an unsatisfactory, makeshift, even with a narrow firebox, and should not be permitted to impair the efficiency of a wide one, although such an inconsistent combination is to be found in some of the latest constructions.

The Atlantic type engine is so well suited to the requirements of high-speed passenger service, and has given such satisfactory results on a number of important roads which have adopted it, that it is not improbable that in this service it will altogether supplant the American or ordinary eight-wheel passenger engine. Comparatively few of the latter class engines have driving wheels as large as or larger than 80 in. in diameter, and with the smaller wheel used in the great majority of cases, the wide firebox is entirely practicable and is in use to a large extent, both with anthracite and bituminous fuel. The Atlantic type engine is not only admirably and perfectly adapted to the application of the wide firebox, without any practical restriction as to depth, or as to the diameter of driving wheels employed, but would also seem to have been designed with such an application specially in mind. Trailing wheels under a narrow firebox do not commend themselves favorably to those who have been accustomed to utilize all weight which may be made available for adhesion, but where the advantages of specially large driving wheels and wide firebox are sought to be combined, they are not only entirely in accord with the fitness of things, but are also apparently the only means by which the desired result may be attained. As representative of wide firebox Atlantic engines, attention may be briefly called to those of the Erie R. R. burning bituminous coal, and the class E1 of the Pennsylvania R. R. which burn anthracite. The Erie engines have Vauclain compound cylinders 13 and 22 in. diameter and 26-in. stroke, 76-in. driving wheels, and a 61-in. boiler with 2,269.8 sq. ft. of heating surface and 64 sq. ft. grate area. While no record of their performance is available at this time, it is reported by the motive power department to be in the fullest degree satisfactory, as there is every reason to believe that it would be. The Pennsylvania R. R. E1 engines have 20½ by 26-in. cylinders, 80-in. driving wheels, and a 67-in. boiler with 2,320 sq. ft. of heating surface and 69.23 sq. ft. grate area. The record made in July, 1899, by the Pennsylvania engines is a phenomenal one, including a run of 24.9 miles with a seven-car train, in 18 minutes, or at the rate of 83 miles per hour, and another of 30.6 miles, with an eight-car train, in 24 minutes, or at the rate of 76.5 miles per hour. It will doubtless be admitted that no narrow firebox would be capable of making steam for such runs as these, which, while of course exceptional in service, are indicative of the ample capability of the engines to meet all the requirements of ordinary high-speed work and to exceed them upon required occasions.

The numerous instances of wide firebox engines now running in ordinary passenger, freight, and shifting service, sufficiently prove the entire adaptability of the wide firebox to use on engines other than those having the largest sized driving wheels, and the recent Prairie and G3 engines of the C., B. & Q. R. R., which are the first examples of independent design in wide fireboxes for bituminous coal, are of interest as illustrating the utilization of a comparatively moderate increase of grate area over that afforded by the narrow firebox, the grate of the Prairie engines being only 42 sq. ft., while at the same time, as deep a firebox is obtained as is believed to be necessary for burning bituminous coal.

The more recent constructions of wide firebox boilers differ in several particulars from those introduced by Mr. J. E. Wootten on the Philadelphia & Reading R. R. in 1877, from which the type took its name. The Wootten boilers proper had quite shallow fireboxes, and a combustion chamber in the waist of the boiler, which was separated from the firebox by a brick bridge wall. The engines being designed for burning anthracite coal, the grate area was very large, being usually 76 sq. ft. or more. The form of combustion chamber employed was objectionable in some particulars, and the firebox was not generally considered to be sufficiently deep for use with bituminous coal. For these, among other reasons, its adoption with the latter fuel has been neither rapid nor general. In later wide firebox boilers, the combustion chamber was omitted, the firebox was deepened, and the form of the crown and outside sheets was changed, to present easier curves and admit of more perfect staying. In some instances, Belpaire tops have been used, and a good example of this form is to be seen in the Prairie type engines. Early in the use of wide firebox boilers with bituminous coal, it was found that the grate area could be reduced with advantage by covering the grate for about 3 or 4 ft. from the front with fire brick. It will be seen

Schenectady 8-Wheel Passenger Locomotive, Fitchburg R. R.
Fitted with the " Front End " Arrangement Shown on Page 201.

that this did not effect any material reduction of firebox heating surface and it attained the additional advantage, which is undoubtedly an important one, of providing a combustion chamber within the firebox.

A wide firebox boiler without a combustion chamber in the waist, and having the front portion of the firebox unprovided with an open grate, either by covering the grate at that point as above described, or by shortening the grate and having the front portion of the firebox in communication with an air-tight ash pan, as generally indicated in the design of Mr. Grafstrom, before mentioned, will be found to answer all the requirements of burning bituminous coal, or low grade fuel of any description, effectively and economically. If the expedient of a fire brick pavement, which is simple and inexpensive, be adopted, the grate area is practically adjustable and more or less may be used, according to the character of the fuel. In either case, a combustion chamber in the firebox is provided, and this without the cost of a special construction for the purpose. The advancement of a combustion chamber, as such, have always been recognized, but the practical objections to combustion chambers located in the waist of the boilers have been sufficient to cause them to disappear from modern practice. In a wide firebox designed some years ago by the writer, the firebox is divided, by a central water wall, into two independent furnaces, each having a brick pavement and bridge wall at such distance from its front as to form a combustion chamber. The water wall terminates back of the flue sheet so that no flues need be omitted and the products of combustion pass from the combustion chamber of each furnace directly into the flues. In a firebox of this class, designed for burning bituminous coal, 45.5 sq. ft. of grate surface is provided in the two furnaces, and the grates can be easily fired, being only 6 ft. 6 in. long by 3 ft. 6 in. wide.

The wide firebox being thus applicable in all types of engines, being the only form in which the grate area may be increased to any extent desired without such increase of length as prohibits proper firing, and being also the only form in which most low grade fuels can be burned successfully, or even burned at all, the claim that it should be standard for any and every type is at least sufficiently reasonable to merit consideration. It possesses every advantage and possibility which can be ascribed to the narrow firebox, together with substantially greater and more important ones, and such objections as have been urged against it, seem, in the light of the satisfactory results of extended practice, to be more imaginary than real.

Mr. G. C. Bishop, Assistant Master Mechanic of the Pennsylvania Railroad at Altoona, Pa., has been appointed Assistant to the Superintendent of Motive Power of the Northwest system of the Pennsylvania lines, with headquarters at Fort Wayne, Ind.

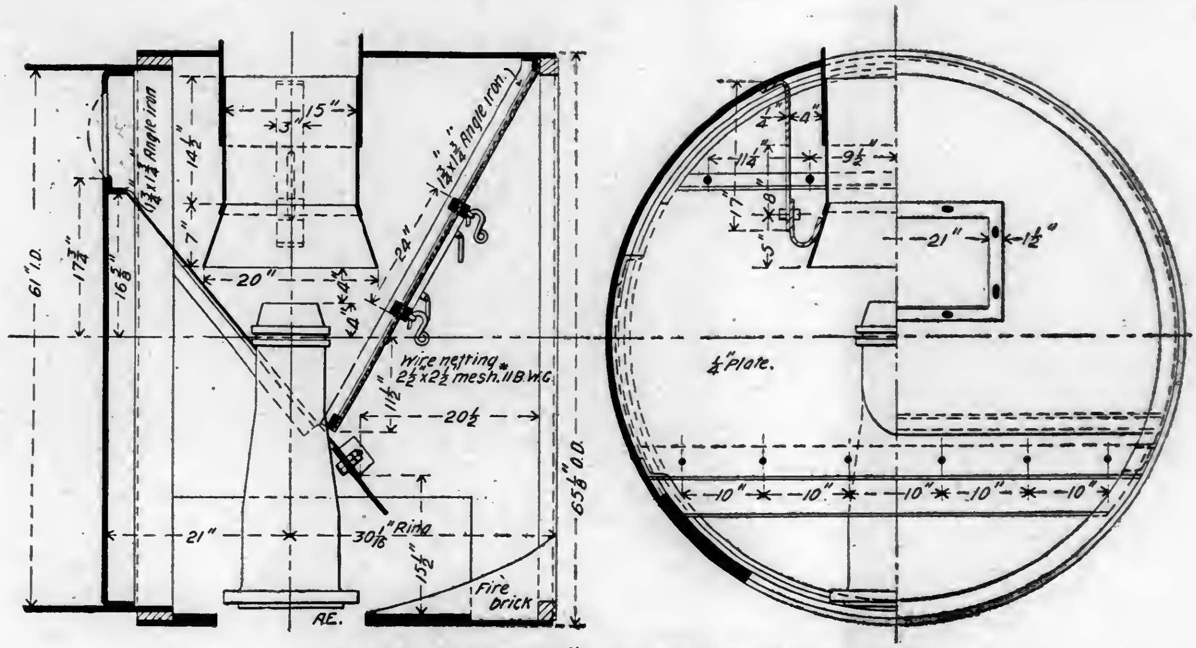
Mr. Willis C. Squire, Engineer of Tests of the Atchison, Topeka & Santa Fe, has resigned to accept the position of Mechanical Engineer of the St. Louis & San Francisco at Springfield, Mo. He is well qualified for this position by a long and unusually wide experience.

TURNER'S NEW SHORT "FRONT END."

Designed by Mr. J. S. Turner, Superintendent of Motive Power, Fitchburg Railroad.

The original extended front end was designed to hold all of the sparks passing through the flues, and for several years after its introduction this was accepted as a necessary feature, but experiments have proven conclusively that only a small percentage of sparks are held. To illustrate, in a 100-mile passenger run, the front end will fill in the first twenty-five miles to a certain line commencing forward about the height of the center of the smokebox door, and gradually tapering down toward the rear, ending just in front of the lower edge of the diaphragm plate. The question then arises as to what becomes of the sparks during the remaining run of seventy-five miles. In the majority of cases the sloping accumulation acts as a deflector and throws the sparks which now pass through the tubes more violently against the netting are not large enough to pass through, and if the meshes of the netting are not large enough, it will become clogged, destroying the draft and the front end must be cleaned out during the run.

One of the conclusions of the committee of the Master Mechanics' Association on the subject of locomotive front ends reporting in 1896 has been very generally accepted and endorsed in recent practice, viz.: the advisability of shortening the smokebox. The committee said: "Sufficient area of netting can be put into a smokebox which is long enough to give room for a cinder pocket in front of the cylinder saddle." The question arises: Why shorten up the smokebox and still continue to use a cinder pocket, for the shorter the box the quicker the accumulation of cinders, provided the old idea of retaining all the sparks is intended? The cinder pocket and long front end are of no practical value whatever to a locomotive, and front ends designed in 1892 with a view of proving this have now resulted in an arrangement designed by Mr. J. S. Turner, Superintendent of Motive Power of the Fitchburg Railroad, and applied to four heavy passenger engines built by the Schenectady Locomotive Works, and eight engines now being built by the Baldwin Locomotive Works, for that road, four of which are duplicates of the eight-wheel Schenectady engines, and four ten-wheel for fast freight service. The recent design is shown in the accompanying half-tone engraving, and represents the short front applied to the eight-wheel Schenectady engines. These engines have a total weight of 130,000 pounds, 85,000 pounds being on the drivers. The cylinders are 19 x 26 in., drivers 72 in., and the boilers carry 200 pounds steam pressure. The heating surface is 2,200 square feet, and the grate area 31 square



New Arrangement of "Front End"—Fitchburg R. R.
Designed by J. S. Turner, Superintendent of Motive Power.

feet. These engines have been in service for the past six weeks, hauling heavy fast express trains, which were previously hauled by ten-wheel engines having 117,000 pounds on the drivers. With a fair grade of bituminous coal the engines steam exceptionally well, with a 5-inch single nozzle, and with coal the quality of "Pocahontas" it will probably be possible to increase the nozzle to 5¼ inches in diameter.

As shown in the drawing, the stack is extended down into the front end with a telescopic adjustment, and the dimension (4 inches) showing the height of the flare above the nozzle is about the correct height. The combination is completed by a deflector plate at an unusually flat angle, terminating in front of the exhaust nozzle, and by the wire netting as shown. To the lower edge of the deflector plate is attached a sliding plate which, in connection with the telescopic pipe, can be adjusted to produce an even draught on the fire. This arrangement of front end is self-cleaning, and if a perfect fit of the deflector plate is made on the sides of the smokebox, and around the steam pipes and exhaust pipe, in connection with a perfect fit of the netting, there is practically a total absence of live sparks from the stack, as the angle of the deflector plate and netting, are so arranged in combination with the fire brick deflector that the sparks are churned and pass out of the stack in small particles, or dust. An arrangement, designed by Mr. Turner and known as "Turner's Front End," practically the same as shown in the drawing regarding the location of deflector plate and netting, with the exception that the exhaust nozzle is carried up to within 18 inches of the inside of the smokebox, is used on a number of engines on the Fitchburg Railroad, and also on the West Virginia Central and Pittsburg, and the Colorado and Southern Railroads, and during the past few months the same construction has been applied to the engines on the Union Pacific Railroad, displacing the diamond stack, which for years has been their standard. A number of other roads are fitting up trial engines, and we believe it is only a question of a very short time when the short self-cleaning front end will be generally adopted as the best practice. The example here shown is considered by many to be the best so far devised. Both arrangements, the high nozzle and the low nozzle with the telescopic pipe, have been found to work satisfactorily, but to meet the present conditions of large boilers, with relatively short smokestacks, the latter arrangement gives the best results.

The advantages of the short front end are summed up as follows: Reduction in length of smokebox and discarding the spark hopper; increased vacuum; larger exhaust tip openings; decrease in back pressure; saving in fuel; better results in caring for bottom steam pipe joints and bolts; greater durability of cylinder saddle strengthening sheet and saddle bolts, also the front end ring and door will not burn and warp. With the self-cleaning front end there is no delay on the road caused by stopping to clean the front end, and no cleaning is necessary at terminals; consequently dust and sparks are prevented from getting into the truck boxes and blowing over the locomotive and machinery. Further and very important advantages are the prevention of fires along the road, and reduction of the weight carried on engine trucks.

Mr. W. D. Lowery, Superintendent of the car department of the Missouri Pacific at Fort Scott, has been appointed Chief of the department for the entire system.

Remarkably good records for economy have been made by ships built and tested last year for the English Navy. Trials at one-fifth power showed that seven ships gave less than 1.9 pound of coal per indicated horse power per hour, and the lowest of the lot—the "Amphitrite"—gave 1.54 pounds.

An electric motor connected directly to a Bement-Miles boring and turning mill, as recently described in "The Iron Age," makes it possible to do away with 70 feet of countershafts, 8 belts, 14 pulleys and 2 cone pulleys, which would be required under the belting system.

A satisfactory and unexpected use has been discovered for old spiral car springs. It has been found that these often contain enough carbon to permit of making good cold chisels. The forging into the necessary form is easy, and the additional carbon required may be applied by a homemade cementation process. The experiment has been tried and chisels, made of old springs, issued to the shops without informing the men that they were different from the usual high-priced material, and the absence of criticism proved that they were satisfactory. Those made in this way cost one-half as much as the high grades of steel formerly considered necessary.

At the session of the American Railway Association held in Chicago on April 25 the executive committee called attention to the fact that after August 1, 1900, it will be unlawful to haul cars in inter-state traffic unless they shall be equipped with automatic couplers. In order to prevent possible embarrassment in the movement of traffic at that time, the association adopted the following resolution: Resolved, That after June 1, 1900, no car not equipped with automatic couplers, whether belonging to a railway company or to private owners, shall be loaded except in the direction of home; and that from that date all such cars shall be returned so as to reach their owners before August 1, 1900.

A large duplex air compressor has been ordered of the New York Air Compressor Company, to be used in connection with the Standard Railway Signal Company's installation on the New York Central & Hudson River Railroad. This machine is the first of two to be located in the handsome engine room of the Grand Central Station, New York.

Duplex, Vauclain Compound for Heavy Grade Service, Baldwin Locomotive Works, Builders.

DUPLEX COMPOUND LOCOMOTIVE FOR SEVEN PER CENT. GRADES.

By the Baldwin Locomotive Works.

An interesting duplex compound locomotive has just been completed by the Baldwin Locomotive Works for the McCloud River Railroad, situated in northern California and extending from Upland on the San Francisco & Portland Division of the Southern Pacific, to McCloud, a distance of 18 miles. The country is mountainous and the requirements included capacity to haul 125 tons, exclusive of the locomotive, up 7 per cent. grades and around curves of 190 feet radius, without exceeding a weight of 6½ tons on each pair of driving wheels. It was decided that these conditions would be met most satisfactorily by a duplex locomotive, which is virtually two complete six-coupled locomotives coupled, back to back, with flexible connections between them to permit of passing curves of short radius. The throttle and reversing gear is so arranged that the two engines are operated as one, and they may be handled by the engineer at his place in either engine. The water tanks are upon the right-hand sides and the wood racks upon the left-hand sides of both boilers. This construction has a number of advantages over the Fairlie type, among them being the avoidance of flexible steam pipe joints and the long exposed steam pipes. The following table gives weights and dimensions:

General Dimensions.

Gauge of road	4 ft. 8½ in.
Cylinders, diameter, high pressure	11½ in.
Cylinders, diameter, low pressure	19 in.
Stroke	20 in.
Valve	Balanced piston
Boiler, diameter	46 in.
Boiler, thickness of sheets	½ in.
Boiler, working pressure	200 lbs.
Boiler, fuel	Wood
Firebox, material	Steel
Firebox, length	53 11/16 in.
Firebox, width	34⅜ in.
Firebox, depth	59 in.
Firebox, thickness of sheets, sides	5/16 in.
Firebox, thickness of sheets, back	5/16 in.
Firebox, thickness of sheets, crown	⅜ in.
Firebox, thickness of sheets, tube	½ in.
Tubes, number	136
Tubes, diameter	2 in.
Tubes, length	12 ft. 9 in.
Heating surface, firebox	148 sq. ft.
Heating surface, tubes	1,804 sq. ft.
Heating surface, total	1.952 sq. ft.
Grate surface	26 sq. ft.
Driving wheels, diameter outside	40 in.
Driving wheels, diameter of center	34 in.
Driving wheels, journals	6½ in. by 8 in.
Wheel base, rigid	9 ft. 9 in.
Wheel base, total	38 ft. 4 in.
Weight on drivers	161,400 lbs.
Weight total	161,400 lbs.
Tank capacity	2,400 gals.

Mr. J. W. Duntley, President of the Chicago Pneumatic Tool Co., cables from Europe as follows: "I have to report fresh orders for 1,000 tools."

Locomotive tenders have been considered as merely tanks on wheels, and it is only recently that attention has been attracted to the possibilities for improvement. Mr. Forsyth has brought together a number of recent designs in his article in this issue and among the noteworthy features the method of standardizing on the New York Central seems to be particularly important. There is no reason why the same tender should not be equally well adapted to freight and passenger service and it may be very convenient and economical to be able to interchange tenders and the saving in repair stock will be large. This idea is broad. It is a good one to start and, we might say, a good one to continue indefinitely. Objections are often raised to standards of construction because they are believed to check and even limit improvement. If standard construction is adhered to indefinitely without regard to contemporary progress, it may have that effect, but the underlying idea of standards as viewed by those who obtain the best results from them is to decide upon them with such care that when completed they represent the best methods for dealing with present problems. New conditions require new standards, and the best development is that which combines advancement with uniform construction. There seems to be a growing tendency in this direction.

"Grosser Kurfürst," the new twin screw steamship, is the latest addition to the Norddeutscher Lloyd fleet. This steamer, which is the twenty-ninth new steamship placed into service by this line in the past 9 years, was built in the yards of Schichau, in Danzig, Germany. She is very wide of beam, has enormous freight and carrying capacity, and the passenger accommodations are all in the superstructure amidships, so that all of the staterooms are light and cheerful. The decorations of the dining-room, vestibule, smoking and drawing rooms are very artistic, and the ship as a whole is a model of German naval architecture. The general dimensions of the "Grosser Kurfürst" are as follows: Length over all, 581 feet 6 inches; beam, 62 feet; depth, 39 feet. The steamer is of 12,200 tons register, has a displacement of 22,000 tons and a capacity of 12,000 tons dead weight. Her motive power consists of 2 quadruple expansion engines of 8,000 indicated horse-power each. Steam is generated by 7 cylindrical boilers, 5 of which are double and 2 single, with natural draft. The heating surface of the boilers is 26,000 square feet, the grate surface in 36 furnaces is 700 square feet, and the steam pressure is 213 pounds. The "Grosser Kurfürst" made her maiden trip May 16 to New York, and will be placed immediately in the service between Bremen and New York.

Mr. R. F. Hoffman, Mechanical Engineer of the Santa Fe, has resigned to accept a position on the editorial staff of the "Railroad Gazette." He will be located in New York City.

Richmond 10-Wheel Locomotive for Sweden.

TEN-WHEEL LOCOMOTIVES FOR SWEDEN.

Ystad Eslof Railway.

By the Richmond Locomotive Works.

Three ten-wheel locomotives with 16½ by 24 inch cylinders have just been shipped by the Richmond Locomotive Works to the Ystad Eslof Railway, one of the private roads of Sweden. The design, with the exception of such details as the smokebox door, the snow plow, English vacuum brake and copper firebox and staybolts, is in accordance with American practice, which was expressly desired by the officers of the road. Belpaire fireboxes, straight boilers, six-wheel tenders and the arrangement of the cab to place the engineer on the left-hand side, are the chief features in the design. The construction was superintended by Mr. D. Olsen, Mechanical Engineer of the road. The dimensions are given in the following table:

Front View of Swedish 10-Wheel Locomot ve.

Rear View of Swedish 10-Wheel Locomotive.

General Dimensions.

Gauge	4 ft. 8½ in.
Weight on drivers	72,600 lbs.
Weight in working order	99,100 lbs.
Wheel base, driving	12 ft. 1 in.
Wheel base, total engine and tender	43 ft. 4 in.
Total length of engine and tender	53 ft. 2 in.

Cylinders.

Diameter	16½ in.
Piston stroke	24 in.
Piston packing	Cast-iron rings.
Piston rod diameter	2¾ in.
Piston rod material	Steel
Steam ports	1¼ in. by 15 in.
Exhaust ports	2½ in. by 15 in.
Bridge width	1 in.

Slide Valves.

Style	Richardson balanced
Greatest travel	5¼ in.
Lap, outside	⅞ in.
Lap, inside	0 in.
Lead in full gear	1/32 in.

Wheels.

Driving, number	6
Driving, diameter	60⅝ in.
Driving, centers, material	Cast steel
Driving box, material	Cast steel
Driving axle journal	7 in. by 9 in.
Crank pin, main	6¼ in. by 5 in., 5½ in. by 6 in.
Crank pin side rods	4 in. by 3⅜ in.
Engine truck, style	Center-bearing swing and swiveling
Engine truck wheels, number	4
Engine truck wheels, diameter	28 in.
Engine truck wheels, centers	Cast-steel spoke
Engine truck axle	Steel
Engine truck journals	5 in. by 10 in.

Boiler.

Type	Belpaire, straight top
Working pressure	185 lbs.
Outside diameter first course	51 in.
Thickness of plates in barrel	½ in. and 9/16 in.
Thickness of plates, roof and sides	½ in.
Firebox, length	74 in.
Firebox, width	34¼ in.
Firebox, depth, front	58 in.
Firebox, depth, back	48½ in.
Firebox, material	Copper
Firebox, plates, sides	½ in.
Firebox plates, back	½ in.
Firebox, plates, crown	½ in.
Firebox, tube	⅞ in. and ½ in.
Firebox, water space, front	4 in.
Firebox, water space, side	3 in.
Firebox, water space, back	3 in.
Firebox, crown stays	1-in. iron
Firebox, stay bolts	1 in. and 1⅛-in. hollow copper
Tubes, material	Charcoal iron
Tubes, length	12 ft. 6 in.
Tubes, number	178
Tubes, diameter	2 in.
Tubes, thickness	No. 12
Heating surface, tubes	1,164 sq. ft.
Heating surface, firebox	98.5 sq. ft.
Heating surface, total	1,262.5 sq. ft.
Grate, style	Cast-iron rocking
Grate, area	17.72 sq. ft.
Exhaust pipe, style	Single
Exhaust pipe, nozzle	3 in., 3¼ in. and 3½ in.
Smoke stack, inside diameter	14⅞ in. at choke
Smoke stack, top above rail	12 ft. 5 in.
Feed water supplied by	Two 7½ Sellers injectors

Tender.

Weight, empty	32,425 lbs.
Frame	Steel
Wheels, number	6
Wheels, diameter	36 in.
Journals	5 in. by 9 in.
Wheel base	10 ft. 6 in.
Tank capacity, water	3,000 gals.
Tank capacity, coal	2½ tons

TRACTIVE POWER OF TWO-CYLINDER COMPOUNDS.—CORRECTIONS.

Attention is called by Mr. C. J. Mellin, Chief Engineer of the Richmond Locomotive Works, to two errors in the article by him printed on page 152 of our May number. The second formula should read

$$P_1 = \frac{P\ (1 + \text{hyp. log } N)}{N} - 15 \text{ instead of}$$

$$P_1 = \frac{P + \text{hyp. log } N}{N} - 15 \text{ as}$$

given in the article. The application of the formula at the end of the article, however, is correct.

In the diagram on page 152 the left-hand arrowhead on the upper line indicating $A + a\ (b - f)$ should have been at the high-pressure compression line, or from the same point as that of the line next below it indicating $ac + a\ (b - f)$.

Also in the reproduction of the third formula in the example at the foot of the column there are several errors in the letters. For $T = \frac{d^2\ P_3\ S}{2d}$ read $T = \frac{d_1^2\ P_2\ S}{2D}$.

ELECTRIC CAR LIGHTING.

In no branch of passenger car equipment has there been such marked improvement in the past few years as in car lighting. After many years of experimenting, a system of electric car lighting was finally evolved and put into practical utility by several different companies. This system is known as the "Axle Light" system, which embodies a simple, independent and complete electric car lighting equipment for each car. The electricity for the incandescent lights in the car is generated from the axle while the car is in motion, and is supplied from a storage battery beneath the car when it is stationary. It is not the present intention to enter into a technical description of the mechanism of electric car lighting equipment, we have already done this, but rather to bring to the attention of the members of the Master Car Builders' and the Master Mechanics' Associations the rapid progress that has recently been made in the introduction and successful operation of this system of car lighting on the passenger coaches of leading railways. The various companies that have for several years been engaged in the manufacture and sale of electric car lighting equipment, have, in the past few months, been merged into the Consolidated Railway Electric Lighting and Equipment Company, with offices at 100 Broadway, New York City, and factories in New York and Connecticut. This company is capitalized for $16,000,000, and has among its stockholders many of the largest and most influential financiers in New York City. Its Vice-President and General Manager, Mr. Jno. N. Abbott, is widely known among railway officials, having been for many years the General Passenger Agent of the Erie Railroad, and subsequently, for several years, Chairman of the Western Passenger Association in Chicago. This consolidated company is now equipping the passenger coaches of several leading railways with its system of electric lights and fans, and in every instance the system is reported to be giving entire satisfaction to the managements. The system is automatic, and the cost of maintenance per car per annum is small, while the superiority of incandescent electric lights over oil lamps and gas of any kind is universally conceded. This company will have one of its complete electric car lighting equipments, including the use of electric fans, as applied to a passenger coach or private car, on exhibition at Saratoga during the conventions and the members of the associations are invited to visit the car and make a thorough inspection and test of the equipment.

PNEUMATIC TOOL LITIGATION.

The Chicago Pneumatic Tool Co. has filed suit against the Philadelphia Pneumatic Tool Co. and the Keller Tool Co., of Philadelphia, in the United States Court of Philadelphia for infringement of the Boyer patents, and in order that " users of pneumatic tools may protect themselves against such infringement" we are requested to print this statement from the Chicago Pneumatic Tool Co.: "These parties have copied our Boyer tools and infringed our patents, and this step is taken to protect our interests under the Boyer patents. We shall follow this suit with like suits against all infringing tools copied after our Boyer tools."

The New York, Ontario & Western Railroad Company has recently installed in its shops a duplex steam driven air compressor built by the New York Air Compressor Company.

The Standard Railway Equipment Company have moved their New York office from 95 Liberty street to the Beard Building, 122 Liberty street.

The Ingersoll-Sergeant Drill Company, New York, had all its air compressors at the Paris Exposition erected and ready to run on the opening day, being the first American exhibitor to operate, and the first exhibitor from any country to run its exhibit by steam. Mr. John J. Swann, late Associate Editor of Engineering News, is in charge of this exhibit.

The Chicago Pneumatic Tool Co. are preparing to give an elaborate exhibit of their pneumatic appliances, at the convention of the Master Mechanics and Master Car Builders' Associations to be held in Saratoga in June. Mr. J. W. Duntley, president of the company, who has been traveling in Europe the past several months on business of the company, will return to the United States in time to attend the Saratoga conventions. The Chicago Pneumatic Tool Co. are making a very extensive display of their products at the Paris Exposition.

In one of the shops of the United States Cast Iron Pipe and Foundry Co., Cincinnati, Ohio, the company has fitted up a room with drawing tables, boards and T-squares as a study room for the use of a number of its employees who are students of the International Correspondence Schools, Scranton, Pa. The class, which numbers about fifty men and includes the general manager, studies on "company time" and is supplied with drawing paper by the firm. All promotions in the shops will hereafter be made from students of this class.

Leather belts have done faithful service the world over for many years, and while the desirability of caring for them has been appreciated, it required the spur of the present pressure of competition and effort to get from each machine its maximum output to bring to this subject the attention it deserved. Among several preparations for restoring to the leather the natural elements required to support its life and increase the effective hold of the belt on the pulley is the "Talismanic Belt Clinch." It is prepared for the purpose of increasing the life, efficiency and capacity of leather belts. The manufacturers say that it contains nothing injurious. They also furnish "facing" for rubber belts and a rope and cordage preserver. The Talismanic Company may be addressed at 485 Main Street, Buffalo, N. Y.; 95 William Street, New York, and 9 Arch Street, Boston, Mass.

AMERICAN ENGINEER AND RAILROAD JOURNAL.

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MASTER CAR BUILDERS' ASSOCIATION.

THIRTY-FOURTH ANNUAL CONVENTION.

Saratoga, New York, June, 1900.

The convention was called to order at 10 a. m., June 18, by the President, Mr. C. A. Schroyer. After the opening prayer by the Rev. Delos Jump, the President introduced the Hon. John Foley, President of the Village Board of Saratoga, who welcomed the association to its seventh convention held there. He referred in a happy way to the inspiring character of the work of the Association and the appreciation of its accomplishments.

President Schroyer then read his address. The past year was referred to as a notable one in the Association, and the past decade was characterized as the most wonderful one in its history. Many things had contributed to the generally satisfactory condition of the country, one of which was the railroad system whereby transportation was made cheaper and quicker than anywhere else in the world. The car building interests occupied in this work held great responsibilities which merited careful and honest consideration of the questions of vital interest coming before this organization.

The total number of cars in the country was placed at 1,356,861, which was an increase during the year of 8,730. The number of cars represented by the membership in the Association was 1,348,131, and at the beginning of last January 1,191,189 cars had been equipped with automatic couplers, since which time practically all of the rest had been so fitted. The speaker referred at length to the fact that sufficient attention had not been given to the maintenance of unlocking devices. This had received the attention of the Interstate Commerce Commission, which had pointed to the fact that couplers defective in this respect were not automatic in that they often required men to undergo the danger of going between the cars. Mr. Schroyer recommended more attention to adherence to the standard construction; he would like to see all the standards covered by the interchange rules. We think that this would be an excellent way to enforce the standards. It has been suggested before, and will probably be accomplished next year. The speaker mentioned the fact that during the year no triple valves had been submitted to the standing committee on that subject, and the same was true of brake shoes. He suggested the desirability of taking the stand, as members of the Association, that new brake shoes submitted for trial on roads should be required to first come before the Brake Shoe Committee for test. An unusual loss of members by death was sustained this year, the number being eleven.

The report of the Secretary and Treasurer showed the condition of membership and finances to be satisfactory. During the year there had been an increase of five in the membership, which, at this time, stands as follows: Active members, 265; representative, 190; and associate members, 8; making a total of 463, as against 458 last year. The amount of cash in the treasury at the time of the convention was $9,836.22, with all bills paid. It was decided that the membership dues should remain without change for the year. A worthy precedent was established in the appointment of the following four members as a nominating committee: Mr. John Kirby, R. C. Blackall, Wm. Mc. Wood and John Hodges. These are men who have been in the councils of the Association for many years.

REPORTS AND DISCUSSIONS.

In this issue we print abstracts of the most important reports, which will be continued in the following number.

Standards and Recommended Practice.

The brevity of this report indicated the general satisfaction with present standards. There were but five recommendations, one of which was in the form of a new design for a journal box and details for 5 by 9-inch axles. The Chairman, Mr. Waitt, urged in strong terms the importance of more uniformity in construction and better maintenance of uncoupling attachments. He presented a suggestion from Mr. Moseley, Secretary of the Interstate Commerce Commission, to the effect that the interchange rules should require the maintenance of coupler unlocking attachments. This was referred to the Arbitration Committee for report later in the convention. With reference to Screw Threads, Bolt Heads and Nuts, the Association considered the recommendations of last year in favor of the adoption of the manufacturers' standard in place of the old sizes, and voted to submit the question of the change to letter ballot for adoption as a standard. Mr. B. Haskell believed it advisable to bring the subject before the American Society of Civil Engineers with the object of securing similar action in connection with bridge bolts, and the necessary action was taken.

The committee recommended in the specifications for steel axles a reduction in the percentage of carbon. It was considered unwise to allow the proportion of carbon in freight car axles used in interchange service to go beyond 0.4 per cent., limiting the proportion in these axles to from 0.4 to 0.25 because of the rough usage of this service, with particular reference to the danger of damage in sudden cooling of hot boxes. Mr. E. D. Nelson cautioned against precipitate action and suggested further investigation by a special committee. Mr. Wm. Forsyth believed it unwise to reduce the carbon without reference to the size of axles, it being established that it was important to have more carbon in large than in small axles. It was clearly an important matter, the size of the axle must be considered, and was referred for report by a special committee next year, who should investigate the question of chemical composition of all steel car axles.

TOPICAL DISCUSSIONS.

"When pressed steel trucks are broken on a foreign road should not repairs be made by the manufacturers or the owners, in place of repairs being attempted by the road on which the car may be?"

Mr. B. Haskell opened the discussion. Thus far there had been comparatively little damage to these trucks, but the necessity for having formers for doing such work made it advisable to take some action as to who should make the repairs. Several members thought it necessary for roads to prepare to do this work themselves, because the use of metal trucks was sure to increase. Mr. Rhodes urged the importance of directing the attention of the manufacturers to the necessity of constructing these trucks with a view of facility of repairs. This had not received enough attention in the past. Mr. Waitt supported the opinion in favor of simplicity, which would render it possible to carry repair parts and apply them easily. At present his practice was to send an accumulation of damaged trucks to the manufacturers for repairs.

"How soon after a new car is built should it be reweighed to modify the original stencil weight; at what intervals should it be reweighed thereafter, and what should be the minimum variation from the previous stenciled weight for which change should be made?"

This was opened by Mr. Delano. The Burlington had a rule requiring reweighing annually, but this was not always done. The drying out of a car during the first hot season amounted sometimes to 1,500 lbs. Accuracy in stenciling light weights of cars was shown to be important from a traffic standpoint. The speaker thought it advisable to take definite action which should render the marked tare weights correct, honest and reliable. Mr. Waitt moved the appointment of a committee to consider the whole subject as stated above, with reference to both foreign and domestic cars, and this was carried.

"Should the link slot and pin hole in the knuckle of M. C. B. coupler be closed?"

Mr. G. L. Potter reviewed the desirability of removing the difficulties due to the weakening of the knuckles in this way. It was shown to be necessary to take up the question of hauling cars out of very sharp curves. The abolition of the slot and retention of the pin holes, the tops of the pins serving for attachment of the ordinary links, was shown to be inadequate. Service in car ferry work, where the question of tides was troublesome, and on mountain roads, required something more than this. There were so many special requirements to be provided for that this action should not be taken until a satisfactory substitute was ready. Mr. Delano thought it possible to reduce the size of the openings even if they could not be filled up entirely. There was no definite action on the question.

REPORTS.

Brake Shoe Tests.

This committee did not consider it one of their functions to test brake shoes unless they had passed the experimental stage, and considered it wise to wait until a number of recent new shoes had been in use for a longer time, deferring report upon these until next year. In the mean time those who desired to submit shoes to test could do so at Purdue University, where the machine is now located, paying for the work. Mr. Delano wished to have the association informed as to the results of independent tests which have been made at Purdue. The results of these, however, are now private information and confidential. This led to a suggestion by Mr. F. M. Whyte recommending asking the committee for specifications of the coefficient of friction for brake shoes. Shoes could then be tested and those which came within the required limits could be brought before the railroads in a very satisfactory condition. This was ordered.

Triple Valve Tests.

The second session opened with the consideration of this subject, which was introduced verbally by Mr. Rhodes. The committee had carried out the instructions of last year inviting the air brake manufacturers to be represented in a meeting to consider revision of the code of tests for triples prior to making comparative tests. The efforts of the committee had not been successful in securing co-operation from the New York Air Brake Co., and no progress had been made. It appeared in the discussion that the Association had gone as far as it could to secure tests through such co-operation. The matter stands where it was left last year, with no apparent hope for a test.

Interchange Rules.

The interchange rules for freight cars were adopted as revised by the arbitration committee and prices as recommended by the committee on prices. This was a good piece of work, which occupied but two and a quarter hours. The passenger interchange rules created an unexpected amount of discussion and the suggested revision was finally voted down because many considered it too radical.

Wheel Circumference Measure.

This report, which contained a design for an improved circumference measure, was ordered submitted to letter ballot.

Design for Journal Box, Bearing, Wedge and Lid for 100,000-Pound Capacity Cars.

This report was criticised in certain particulars. The gauges submitted were incomplete in some ways. The matter of gauges for boxes and wedges was referred to a committee for report next year and the report itself was ordered to letter ballot.

Loading Long Material.

This subject has been before the Association for several years and great improvements have been effected in loading materials, which from their form or weight are awkward to handle in trains. Besides lumber, such freight as logs, pipe, stone, ties and tan bark are provided for. The report of this year includes the former rules brought up to date to meet newly developed conditions by a number of important additions and a few minor changes. Mr. Leeds, of the Louisville & Nashville, has pulled the laboring oar in this work and deserves a great deal of credit for the rules. The report was referred to letter ballot as recommended practice.

Center Plates.

In the presentation of the report the necessity for smooth-fitting and adequate lubrication was made prominent. Ideas as to center plates were shown to be of great variety and necessity for lubrication was apparent.

Side Bearings.

This and the previous subject were considered simultaneously. It was at once apparent that these have a very important bearing on the design of cars. There was a strong inclination to favor further investigation of the action of roller side bearings. A report will be made next year by a committee in which side bearings and center plates will be considered as parts of the same subject. It was regretted that the committee on center plates could not recommend anything as a standard.

Draft Gear.

Experiments seem to be necessary in order to establish the weak points in draft gear. Mr. Bush estimated the proportion of cars on repair tracks for draft gear repairs at 30 per cent. of the whole number to be found in yards. Not only the draft gear was affected, but also the entire ends of the cars. The fact that there are few locomotives now used in heavy freight service which cannot exert more than 30,000 lbs. tractive force and the present low limit of capacity of ordinary draft gear to about 19,000 lbs. showed how inadequate present draft gear is. Mr. Rhodes supported Mr. Bush in regard to the necessity for tests and considered draft gear improvement absolutely necessary. The whole question was referred to the committee again and the executive committee instructed to outline tests. Mr. Delano recommended the rear ends of tenders as a favorable place for testing draft gear, because of the severity of the service which gave results quickly. The Westinghouse friction draft gear was prominently mentioned as being worthy of attention by the committee.

Air Brake Appliances and Specifications.

Careful instruction to repair men was shown in the discussion to be very important, especially in oiling the brake cylinders. The chief item in construction requiring attention seemed to be the avoidance of angles and bends.

Tests of Master Car Builders' Couplers.

The committee had not been able to test any couplers during the year, but had confined its efforts to redesigning the apparatus for testing which was put into the form of working detailed drawings. Purdue University has offered to build the machine at its expense under the direction of the committee, placing it at all times at the disposal of the Association.

In addition to this gauges, the marking of couplers, increased size of the coupler shank and the advisability of closing up the link slot and pin-hole in coupler buckles were brought up by the committee. Mr. Waitt proposed an arrangement for testing couplers whereby a coupler may be submitted to the committee by any road represented in the association and the tests will be made at the expense of the association.

TOPICAL DISCUSSIONS.

"To what extent is it desirable to equip cars with permanent check chains now shown under recommended practice of the Association."

This subject was introduced by Mr. Sanderson, and as the discussion brought out the close relations between this subject and that of metal dead-blocks, it was referred for consideration to the committee on this subject.

"Good Methods for Terminal Cleaning of Passenger Cars. Is it advisable to have oil in cleaning mixtures?"

Prominence was given in the discussion to the destruction of the varnish caused by washing the previously dry surface of the cars, except at relatively long intervals. The use of water unnecessarily was found to be as destructive to the life

of the varnish as the weather, too frequent washing with water causing cracks in the varnish. Considerable care should be used in the employment of oil in the compound used for cleaning and cutting the dirt. The use of oil, such as linseed, formed a thin skin on the surface when dry, covering up the dirt in the cracks, and in the beading work of the trimmings, and this was difficult to remove. The practice of the New York Central was to use the cleaners not oftener than once in three months. Water was used only in wet weather, the dry cleaning sufficing at all other times. The cost of cleaning cars varied considerably on different roads. On the Chesapeake & Ohio it was 30 cents per thousand miles for cleaning both the inside and outside, which was taken as an average figure. In view of the technical character of the subject, and the fact that only painters were sufficiently informed to treat it properly, the topic was referred to the Master Car Painters' Association.

Closing Business.

The closing business included the usual resolutions of thanks to those who had contributed to the success of the convention, and the election of officers resulted as follows: President, Mr. J. T. Chamberlain; First Vice-President, Mr. J. J. Hennessey; Second Vice-President, J. W. Marden; Third Vice-President, A. W. Brazier; Executive Committee, E. D. Bronner, J. H. McConnell and William Apps; Treasurer, John Kirby.

AMERICAN RAILWAY ASTER MECHANICS' ASSOCIATION.

THIRTY-FOURTH ANNUAL CONVENTION.

Saratoga, New York, June, 1900.

The convention was called to order at Saratoga June 20, 1900, by President J. H. McConnell. The prayer was offered by the Rev. Dr. Jump, and the opening address was delivered by Mr. A. J. Pitkin of the Schenectady Locomotive Works. The speaker in a happy way directed the thought of the Association in the direction of the responsibilities brought to the members by the fact that the locomotive must earn every dollar of revenue of the railroad. The present bearing of the locomotive in transportation was expressed in the reference to the fact that 1¾ pounds of coal, which could be held in the hand, contained sufficient energy when burned in a locomotive firebox to transport a car containing 1,000 bushels of wheat one mile. This also testified to the perfection of present designs.

The president in his address stated that the affairs of the Association were in the usual satisfactory condition. The year had been a remarkable one in locomotive work, both foreign and domestic. During the year 1899, 2.196 locomotives, costing $25,000,000, were built in the United States.

The recent great advance in weights of locomotives was commented upon in connection with the increase in cylinder power as indicating remarkably rapid development. Tenders had not been behind the locomotive in growing. Cast steel had advanced in favor for locomotive parts; nickel-steel had not yet come into general favor, but piston valves were rapidly gaining. The increased power of the locomotive was the most important and promising improvement. Train weights had greatly increased and the value of the tonnage rating system was recognized in showing the advantages in their true light. The compound was advancing, 330 having been built in the year 1899. Shop practice, electric driving, compressed air, improved tools received the speaker's attention in a statement favoring the use of methods which seemed to be best adapted to the special conditions in shops. In reviewing the subjects before the convention, the speaker gave special prominence to the comparison of statistics on the ton-mileage basis and uniformity in making up statistics for the same work for various purposes.

The reports of the secretary and treasurer were received. The membership stood as follows: Active, 620; associate, 19; honorary, 26; total, 665. The finances were in equally satisfactory shape; the amount of cash in the treasury was $3,-468.47, with all bills paid.

The four scholarships at Stevens Institute of Technology were all filled, and as a vacancy will be open for the autumn examinations, candidates should communicate at once with the Secretary. There are at present no applicants, and Mr. MacKenzie moved that the privileges of the scholarships should be extended to the locomotive works in case there are no applicants from the railroads. The preference stands as follows: First, the sons of railroad men; second, railroad employees who may not be sons of members; and last, boys employed in locomotive works.

A lot of time was spent over the question of the admission of several honorary members, but steps have been taken to avoid a repetition of the occurrence.

REPORTS.

"What Can the Master Mechanics' Association do to Increase its Usefulness?"

This sort of report was a novelty, and we present its conclusions elsewhere. In spite of the fact that the report contains a pointed criticism of the practice of reading reports in full, the Chairman of the committee was specially requested to read it in full. This is mentioned because a presentation of papers by abstract is generally considered vitally important in the prompt conduct of business.

The report contained a number of suggestions which, if carried out, would require changes in the constitution, and a resolution offered in the report referring them to a committee for further report resulting in the appointment of Messrs. Quayle, Vauclain and Gillis. The matter of the preparation of an elaborate index of the proceedings was referred to a committee, Messrs. F. A. Delano, S. P. Bush and C. M. Mendenhall.

Mr. Deems emphasized the importance of the suggestion of the committee with reference to preparation for the discussion of the subjects, and also of the consideration of many important features of motive power work outside of the locomotive. Many of the suggestions will probably be acted upon next year. It would be a good plan to have such a report every five years.

TOPICAL DISCUSSIONS.

"Nickel Steel as a Journal Bearing. Is there any noticeable increase in friction or wear, as compared with the ordinary steel or iron?"

Mr. W. H. Lewis, who presented this subject, had no reason to believe that it did not make a good bearing. Mr. Vauclain spoke from the standpoint of the locomotive builder, and urged the importance of securing the best nickel steel. The processes had been improved and there was no reason for hesitating in using this material if made by the best makers. Mr. Quayle asked for information as to the heating of nickel steel axles. Mr. Gillis mentioned the fact that this material was considered by the Navy Department as beyond experiment in this respect. Nickel steel has long been used for marine shafts running at high rates of speed. Mr. Pomeroy also pointed to the necessity for getting the best nickel steel. Those who were disappointed in the results obtained when they expect to repeat the experience of naval service had probably not obtained the quality of steel used in that service. It was made clear that the process of manufacture of nickel steel was very important and that only the best should be used.

REPORTS.

"The Extent to Which the Recommendations of the Association have been put into Practice."

This was an elaborate and painstaking review of the entire records of the Association, and included an index of the proceedings and a valuable summary of the large number of recommendations made from the beginning. There was no discussion.

Relative Merits of Cast-Iron and Steel-Tired Wheels.

The committee had not been able to get data of any value

from the members. Only two had replied to the committee's circular this year. The committee was continued. Mr. Rhodes explained his confidence in cast-iron wheels. The greatest danger of breakage of cast-iron wheels formerly was largely due to the heating effect of the brake shoes. The use of the thermal test had the effect of improving the character of the wheels, and this had practically placed the wheels beside steel wheels in safety. At first there was difficulty in securing wheels to meet the thermal test. They had since been made to meet it. The application of brakes necessitated the use of this test, and Mr. Rhodes stated that in two years' experience with the thermal test he had not known of a single case of cracking in the plate. He clearly put himself on record as favoring the cast-iron wheel under the thermal test as being safer than some steel wheels. In short, the cast-iron wheel had been improved more than some of the steel-tired wheels.

Ton-Mile Basis for Motive Power Statistics.

The discussion of this subject developed the fact that there were not only differences of opinion among the members, but also among those of the committee, as to whether the weight of the engine should be included in the weight of the train, or whether the records should be stated in the weight of the trains behind the tender. Messrs. Henderson, Marshall and Deems took the view that the comparison should be made on the basis of the load back of the tender. Mr. Marshall directed attention to the desirability of stating the mileage statistics as well as the ton mileage, because of the fact that there are important expenses which depend on the engine mileage quite independently of the ton mileage. For these, which include certain round house expenses, the ton mileage comparison would be misleading. He thought that if switching statistics are kept on the ton-mileage basis at all, they should be prepared with reference to the total tonnage handled on the division. Mr. Delano called attention to the well-known fact that the ton-mile as a unit did not always mean the same thing. He thought that the work of reform in the subject of comparison of statistics was progressing, but much patience was required to bring about the necessary improvement in this very important matter. He emphasized particularly the necessity for making the units more reliable in order to give fair measurements. Whether or not the weight of the engine was included in that of the train, the really important thing was to account for the light mileage. Mr. Rhodes urged improvement in the methods of measuring the work of the men, because carelessness in this respect destroyed their confidence in the fairness of the comparison.

Throughout the entire discussion it was indicated that many of the members felt that light engine mileage would probably take care of itself, and the really vital point in the entire treatment of the subject was introduced by Mr. Deems, who favored the greatest simplicity of the statistics, even if it interfered somewhat with their accuracy, for the sake of getting the returns promptly. Figures brought out at the middle of the month were more valuable than more elaborate and more accurate figures brought out at the end of the month. The Association did not appear to consider it important to attempt to show the differences due to the differences in designs of engines in the statistics, such as those improvements which give high tractive power in proportion to the weight of the engines.

Flanged Tires.

The report of the Committee on Flanged Tires, which is one supplementing the report of last year, was read by Mr. S. Higgins, Chairman of the committee. The original report was made on 10-wheel locomotives only, while this, the second report, covers mogul, 10-wheel and consolidation locomotives. Nearly all of the roads have experimented with all flanged tires, and a number of the important roads report their use on their mogul, 10-wheel and consolidation engines. The Burlington road two years ago placed flanged tires on all of the wheels of the mogul engines of a certain division of the road, and Mr. Deems reports that the tires last fully twice as long without turning. The point brought out by Mr. Hawksworth was of a very interesting nature, as the road with which he is connected has 16-degree curves and 3 per cent. grades. The rails of the track were laid on soft-pine ties, no tie-plates being used. They experienced a great deal of trouble with blind tires and also a great deal of difficulty in running the engines with the drivers all flanged. It was impossible to keep the track in gauge, and for a short time these engines were laid off. Finally, the second pair of wheels were taken out and blind tires 2 in. wide were put in to prevent the engine from getting off the track.

Mr. Delano believed that the flanging of the wheels of mogul and consolidation engines is done at the expense of the track, for on some sharp curves inside rails are necessary to keep up the blind tires as they slide over the main rail. On such engines, with all wheels flanged, there must necessarily be some severe strains set up in the rails. Another method to diminish flange wear, without injury to the track, Mr. Delano believes to be that of making either a single or double truck do more of the guiding of the engine instead of throwing it on the first pair of drivers. One division of the road with which he is connected has ten 10-wheel engines, the double truck being equipped with a center pin. The front drivers of the engines are blind and the rear two flanged. These engines are running in fast passenger service and take the sharpest of curves very smoothly.

The Central Railroad of New Jersey has 25 heavy consolidation locomotives weighing 205,000 lbs. These engines, Mr. McIntosh says, have been in constant service for over a year. The wheels are all flanged, and are giving the best of service.

Mr. Vauclain, in giving his views on the subject, from the standpoint of the manufacturer, said: "It seems to me that the conclusions of the committee are all right. If you take a consolidation locomotive having a 16-ft. wheel base and place it on a 20-degree curve, you find that the height of an arc in a 16-ft. chord is about 1.35 in. If the track is put down ¼ in. wide, ¾ in. play, 4 ft. 8½ in. gauge, you have 1 in. of the 1.35 in. already taken off by simple measurements. We have .35 in. to provide for, supposing your driving wheel would come exactly in the center. But your driving wheel does not come in the center of the arc, but the two center wheels are spaced on either side of the center. The distance from the tire to the track at that point would probably be about 3/16 in. less, with a lost motion between the hubs of the driving wheels and the box of 1/16 in. on the side.

"I think it is perfectly safe to work upon for all locomotives of modern design up to curves of 20 degrees. We have been building hundreds of locomotives for all ordinary railroad practice in the past four years with as large a wheel base as 16 ft. 4 in., and having all wheels with flanged tires. I think that the guard rails, frogs, switches, etc., can be safely arranged for engines with large wheel base."

Mr. Quayle had been testing flanges on all driving wheels during the past year on his engines in the switching yards at "battle ground," Chicago, where they have experienced the most trouble with flange wear, and it has reduced this trouble very much, and he favored the practice of flanging all driving wheels. It seems to be the consensus of opinion that if the locomotive is adjusted properly, with the right amount of clearance, and if the track is of the proper elevation and gauge, the flange wear will be diminished by this practice.

Compound Locomotives.

Mr. Vauclain took exception to the first conclusion of the committee, which was that "compound locomotives have not yet come into general use in America, but are gradually emerging from the experimental stage." This, he declared, should be erased from the report. We are constantly making changes in design of the simple engine and do not consider it in the experimental stage; we therefore have no right to say that the compound is not past its experimental stage. While compounds

have not been generally adopted by the railroads of this country, they are coming rapidly into use for both freight and passenger service. This is evident from the figures given by Mr. Vauclain to the effect that 50 per cent. of the locomotives built by the Baldwin Works are of the compound type. The Society of Engineers in Russia had decided that the 4-cylinder compound is an acceptable locomotive for the Russian Government, and they had been building 2-cylinder compounds for a number of years. Mr. Delano was of the opinion that the compound locomotive is in an experimental stage on some roads, but it could not be said to be in such a state on railroads that have from 25 to 150 of these locomotives in daily service. The Burlington road had not many compound locomotives, but with the two-cylinder compounds in freight service exceedingly good results are obtained. This road is so satisfied with them that they are going to order more. In the committee's conclusion No. 6 it states that there should be no difference in the size of drivers in the compounds and simple engines in the same service. It is believed that slow piston speed is to be sought for in all engines, but are there not good points in favor of larger drivers on the compound as compared with the simple engines? Mr. Deems' reply to this conclusion No. 6 was that the report was based entirely on the replies received from the circulars sent out, which show reports from 15 members that there is no difference in size between the drivers, and one reports a slightly larger wheel for both freight and passenger service.

Prof. Goss, in supplementing Mr. Vauclain's remarks, said that there is a sense in which we may consider all locomotives in an experimental state. The process of increasing weight of locomotives from 100,000 to 250,000 lbs. involved a great deal of experimenting. It will be well to bear in mind that the compound engine is a more perfect machine as it stands to-day in this country than in any other. The process of compounding has gone ahead of that of any other country. An important point was brought out by Mr. Gibbs that was not touched upon by the committee; that of the maximum possible weight on drivers, the maximum boiler capacity which is limited by weight on the drivers. It has been demonstrated that the compound locomotive can save from 15 to 20 per cent. in fuel. This means a very much better use of heating surface. We are going to get more out of a given weight in a compound than for the same weight in a simple engine.

The remarks of Mr. Sague brought up the impossibility of making the reciprocating parts of compound locomotives as light as those of simple locomotives. There has been a tendency to reduce to a minimum the weight of pistons, crossheads and piston rods for the purpose of diminishing the reciprocating counterbalance on the track, and builders have not sufficiently considered this with the compound. It is said that a single compound locomotive among a number of simple locomotives has the unfavorable position. His experience had been rather different from this. The pooling system was used on a compound, and a lot of 18 simple locomotives which were recently built, and the results of the compound were so favorable that the men tried to get the compound in preference to the simple engines.

Mr. Sague believed that there was no reason to consider the two-cylinder compound as handicapped by clearances yet. It was a satisfactory engine for passenger service, but would not show as great advantage over the simple engine in passenger as in freight service.

There are many roads that are not using compound locomotives, and Mr. Waitt spoke with reference to the New York Central. The past experience and general sentiment against them in the past had caused a number of compounds to be changed over to simple engines. They also had some compound switchers which were not found entirely satisfactory in operating them as compounds. But the art seemed to be progressing rapidly, and he felt sure from the reports of the committee and the discussion that he had personally received a great deal of light, and had a very strong temptation to give such consideration to the compound as he had not given it before.

TOPICAL DISCUSSION.

"Has the limit of length of tubes, two inches in diameter, been reached in locomotive practice?"

Mr. Vauclain says we have not reached the limit in length of 2-in. tubes, and prophesies that with the properly-designed engine we shall be using in the near future tubes 20 ft. in length. This was rather a bold statement to make, but when we consider that 15-ft. tubes are being used at the present time on the Chicago & Northwestern, 15 ft. 1 in. on the Fitchburg, 15 ft. on the Chicago, Rock Island & Pacific, and even 16 ft., as in the case of the Chicago, Burlington & Quincy, it does not seem improbable that the additional 4 ft. may be added in the future. The first question which would naturally present itself to those not having had experience with tubes as long as 15 ft. would be as to their vibration and the tendency to break loose at the tube sheets and cause leaky flues. This point was discussed by Messrs. Higgins, McIntosh, Brown and Quayle, who are using tubes of this length, and they are having no trouble with leaky flues. The limit of the length of tubes is determined by the tendency of the tubes to stop up and the probability of leakage. A tube when submerged in water has very little chance to vibrate as it is partly supported by the water. If brass and composition tubes 15 ft. in length have been used successfully, and give no trouble, there is reason to believe tubes 20 ft. in length will not.

Metal Versus Wooden Cabs for Locomotives.

Mr. Sague of the Schenectady Locomotive Works opened the discussion by giving a few advantages of each. The most serious objection to metal cabs is undoubtedly that of increased weight, 900 to 1,300 lbs., and for some special cabs as much as 1,500 lbs. There is an increased first cost for metal cabs of $90 to $100 over those of wood. But the low cost of maintenance is a point in their favor, the paint will last a great deal longer on metal cabs, and in hot and moist climates the steel cab is almost necessary.

At this point in the proceedings a committee reported on the changes in the constitution recommended by the committee on "What Can the Association Do to Increase its Usefulness?" These changes and a number of the suggestions made in the report will come up for discussion next year. Mr. F. B. Miles was elected to honorary membership.

REPORTS.

Journal Bearings, Cylinder Metals and Lubrication.

This report was presented by Mr. W. C. Dallas, Chairman of the committee. The discussion was opened by Mr. G. H. Clamer of the Ajax Metal Company, who offered a brief but comprehensive statement concerning the place of lead in bearing-metal alloys. The requirements of bearing metals were classified as follows: 1. Least liability of heating. 2. Sufficient strength to prevent squeezing out under load, and high melting temperature. 3. Least abrasion in service. 4. Least possible abrasion of the journal. For journal bearings alloys of copper, tin, lead and zinc were generally used in the following groups: 1. White metals of tin, lead and zinc. 2. Bronzes of copper, tin and zinc. 3. Plastic bronzes, such as phosphor bronze, 4. Copper, tin and lead alloys. It was generally considered that hardness was necessary to secure good wearing qualities, but the speaker considered that a mistake, his point being proven by the wear of a 1/16-in. lead lining for 9 months without the lead being entirely worn out. The first and third possessed good frictional qualities. These qualities increased in proportion to the increase in the amount of lead which was properly combined in the alloy, and by adding a small amount of nickel the proportion of lead would be increased.

In the matter of cylinder iron Mr. F. M. Whyte spoke of favorable experience with false valve seats and cylinder bushings. Their value lay in the possibility of using metal for the

cylinders which was best adapted to prevent breakage, while the wearing surfaces could be made hard to increase their life.

Piston Valves.

The discussion was in all respects favorable to this type of valve, showing plainly that it had gained friends. It was spoken of as completely successful in principle, and its weak points were being strengthened through experiments and experience. The Burlington now has 65 engines with these valves and they are used on all new ones. On the Canadian Pacific some difficulty had been experienced with defective lubrication and wear of piston valves which had stems which were "off center." Mr. Delano spoke of the interesting feature of solid piston valves with central steam admission which caused them to run away from the steam. The pressure of the exhaust steam coming on the ends of the valve alternately caused it to move in the direction of motion of the valve stem. No serious objection was raised to this action, but it is believed that the simple remedy which has been applied, of making the valve hollow, had the disadvantage of bringing cold exhaust steam too close to the hot entering steam.

Prof. Goss mentioned the saving of power by reduced internal resistance of the engines as a secondary matter in view of the serious distortion of the steam distribution with the slide valve which was caused by high resistance to the movement of the valve.

Those who have designed valve motions for piston valves with central admission have discovered the peculiar effect upon the equalization of the cut-off of attempts to secure direct motions by reversing the usual positions of the eccentrics. Mr. Henderson mentioned this. Central admission required direct motion without the reversal of the motion by the usual rocker shaft, and if the eccentrics are changed instead of rebuilding the valve motion with the omission of the rocker, the distribution will be seriously distorted.

Spring rings were considered by Mr. Henderson to possess advantages over other forms of packing rings for piston valves. He believed that it was necessary to provide packing which will adapt itself to the bore of the valve bushings when they become worn larger at the center of the range of motion of the valve, where the wear is greatest. He did not think that rigid rings would be as satisfactory because they would not accommodate themselves to the enlargement of the bushings due to the increased wear over the range of short cut-offs where most of the wear comes.

Power Transmission by Shafting vs. Electricity.

This report is generally considered the best brought before the convention. We think it the ablest paper on electrical distribution for shop purposes that has appeared anywhere. Some disappointment was expressed privately that there were not more data as to the amount of power required to operate individual machines, but the purpose of the committee was to treat the subject in a much broader way. Many have looked to electrical distribution for a reduction in fuel bills, and while this is justified, the real function of such distribution is in the improvement of shop methods which increase output, permit of saving in labor, and improve the general convenience of operation. The Baldwin Locomotive Works began to decrease their laboring forces at once when motors were put in, and this was the most important result. We print this report nearly in full, and earnestly commend it to our readers. It offers reasons why they should consider electric motor driving and it presents valuable practical suggestions, based upon wide experience, as to the selection of systems to suit their conditions. This report is given first place among those of the Master Mechanics' Association in this issue. The discussion was somewhat disappointing, although it was clear that the impression desired by the committee was made, to the effect that electric driving made it possible to effect a much needed revolution in shop methods, and that it was this business improvement which should make electrical systems attractive. While the report did not say so in words, it is sufficiently apparent that the present wonderful capacity of the Baldwin Works, with their cramped location, is chiefly due to the excellent use which is made of motor driving.

In the discussion the question of voltage came up. While 500 volts meant economy in wiring, 220 volts gave better results in the motors, and the lower voltage led to better care of the brushes of the motors. With the higher voltage the tendency was to defer attention to the motors. The current, while not dangerous, was such as to cause some inconvenience. Mr. A. L. Rohrer (General Electric Company) spoke of the advantages of direct current over the alternating induction motor because of the speed control. Voltage was largely a question of conditions, but probably about 250 volts was best adapted to railroad shops. The value of "taking the tool to the work" was made prominent, and also that of the possibility of measuring, with an ammeter on a shop tool, the amount of power required for various kinds of work.

Best Type of Boiler for Shop Purposes.

This report did not bring out the amount of discussion that was expected. It probably will, however, have the effect of directing attention to the desirability of giving more attention to shop steam plants.

TOPICAL DISCUSSIONS.

How to Make Pooling of Locomotives a Success.

Mr. G. W. Rhodes presented in his characteristic way the principle of pooling as illustrated by the livery stable business. He did not appear to favor pooling, but if it is necessary in order to get more work out of the engines he would put back into the care of the engines the money saved in interest on the amount of invested capital which was avoided by pooling. Mr. Henderson showed it to be advantageous to wear locomotive tires out rapidly in, say ten years, because in that time they were obsolete anyway. It was apparent that many did not believe in pooling, but everybody seems to be trying, by means of double crewing or pooling, to get more mileage out of engines. In time-freight service on the Chicago & Northwestern it had been found satisfactory to put three crews on each engine, whereby 404 miles per day were obtained. With this method the mileage was sufficient and the responsibility for the care of the engines was placed on regular men as it could not be in pooling. We should say that the adverse criticisms of the speakers on pooling were directed against abuses of the system and neglect to look after the repairs rather than the principles of pooling.

Graphite As a Locomotive Lubricant.

Mr. G. R. Henderson opened this discussion. Graphite was believed to be a good lubricant but it had been found difficult to get it upon the bearings.

Closing Business.

After receiving the report of the committee on subjects for next year the following officers were elected: President, Mr. W. S. Morris; First Vice-President, Mr. A. M. Waitt; Second Vice-President, J. N. Barr; Third Vice-President, G. W. West; Treasurer, Angus Sinclair.

The Department of Mechanical Engineering at Purdue University formally dedicated on May 28th a 2,000,000-gallon water works pumping engine recently presented to the laboratory by the City of LaFayette. This pumping engine was built by the Clapp & Jones Manufacturing Company of Hudson, New York, in 1875, and is a fine example of a duplex walking-beam pump. As installed in the laboratory it will serve as an example of this type of pumping engine, and in addition to its historical value, will furnish an ample supply of water for hydraulic experiments.

The washing of oily waste at the stations of the Chicago Edison Company is highly profitable. From 100 lbs. of oily waste about 40 lbs. of clean waste and 40 lbs. of oil are recovered. The waste is put through a washer consisting of a train of rolls over which a stream of hot water is running. This extracts nearly all of the oil and much of the dirt. The oil and water are caught in a receptacle, the oil separated and passed to an oil purifier and the waste put into a drier. The oil is purified by settling and boiling. A complete account of this and other operating economies in central-station practice was given in a paper by Mr. W. L. Abbott, read before the National Electric Light Association recently.

LOCOMOTIVE TENDERS.

Several Examples of Improved Practice.

By William Forsyth.

(Concluded from page 184.)

Pennsylvania Six-Wheel Tender for Class E 1 Engines.

Another example of six-wheel tender for fast passenger service is shown in Figs. 9 and 10, which represent the tender of the Pennsylvania Railroad class E 1 engine, which was fully illustrated and described in our June issue. In this case the middle and rear axles are equalized. The tank carries the coal above the water and holds 4,000 gallons. The coal runs and fireman. This is in marked contrast with the usual ineffective fastenings, and the practice is suggestive of a necessary improvement in tank fastenings. The brake cylinder is at the rear and vertical. It operates a bell crank with two arms projecting vertically downward to the equalized brake system. Another arm takes the hand brake connection. In the front end of the tank structure four closets are built for clothes, tools and the steam pump used in connection with the steam heating system for the train. The water space bracing consists of 2½ by 2½ by 5/16-in. angles, spaced 2 ft. 10 in. apart, and connected across by 6-in. plates. This tender has an excellent arrangement of draft gear in which the drawbar has 1⅞-in. lateral play each way from the center. The design employs iron and steel throughout and is made to receive the Janney coupler. The buffer is a plain two-stem plate with springs

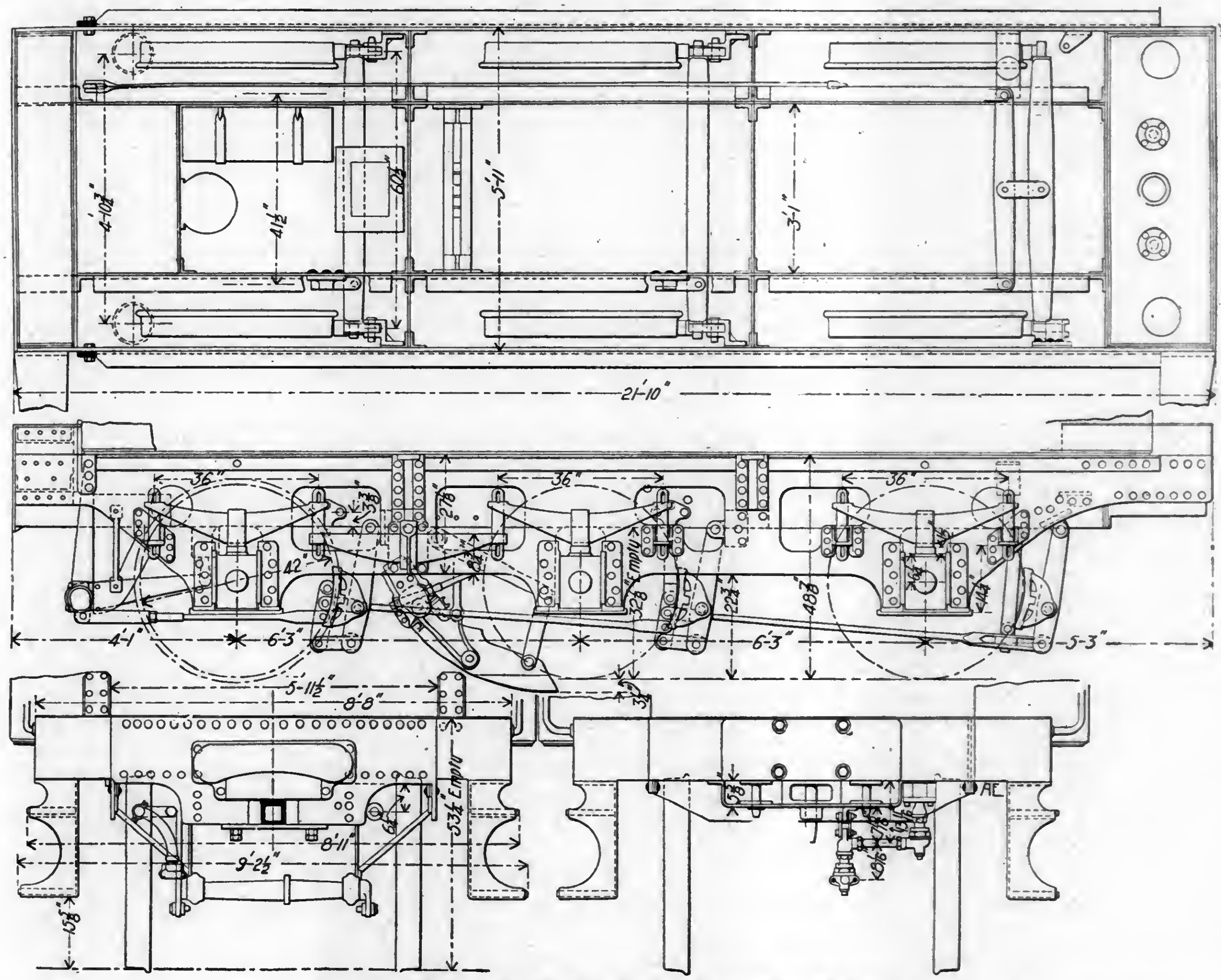


Fig. 9. Frame for Six-Wheel Tender Pennsylvania Railroad.

down to the fireman at an elevation about one foot above the foot plate, which is convenient in view of the high fire doors. The usual wooden flooring on top of the frames is omitted in this design.

The main frames are outside of the wheels and the boxes are carried in bracketed pedestals bolted to these frames. The main frames carry an internal cellular system with longitudinal stiffening plates and cross girths which attach to the main frames between the wheels. The tank rests between box girders projecting above the frames at the front and rear ends, the front one being much deeper than the one at the rear. The tank is wedged tightly in place and is held by special fastenings riveted to it and to the frames, the purpose being to hold the tank in case of collision, so that it will not be torn loose by the shock and endanger the lives of the engineer which are not equalized with the coupler, and the guides for the follower and buffer are steel castings. The buffer and draft springs are enclosed in metal boxing, the whole arrangement being the most durable that we have seen.

These tenders are supplied with the form of balanced track tank scoop which was fully illustrated on page 283 of this paper in November, 1896, and the fact that the same drawings were used for the scoops of the class E 1 engines testifies to the attention this road gives to designing. The experience of four years has not developed a single desirable improvement in this detail. The interesting feature of the scoop is the balancing of the lower part so that it may be raised from the trough at high speed. It has been demonstrated that water may be taken at speeds of 70 miles per hour. Experiments indicate that 3,000 gallons may be taken in 10 seconds at a speed

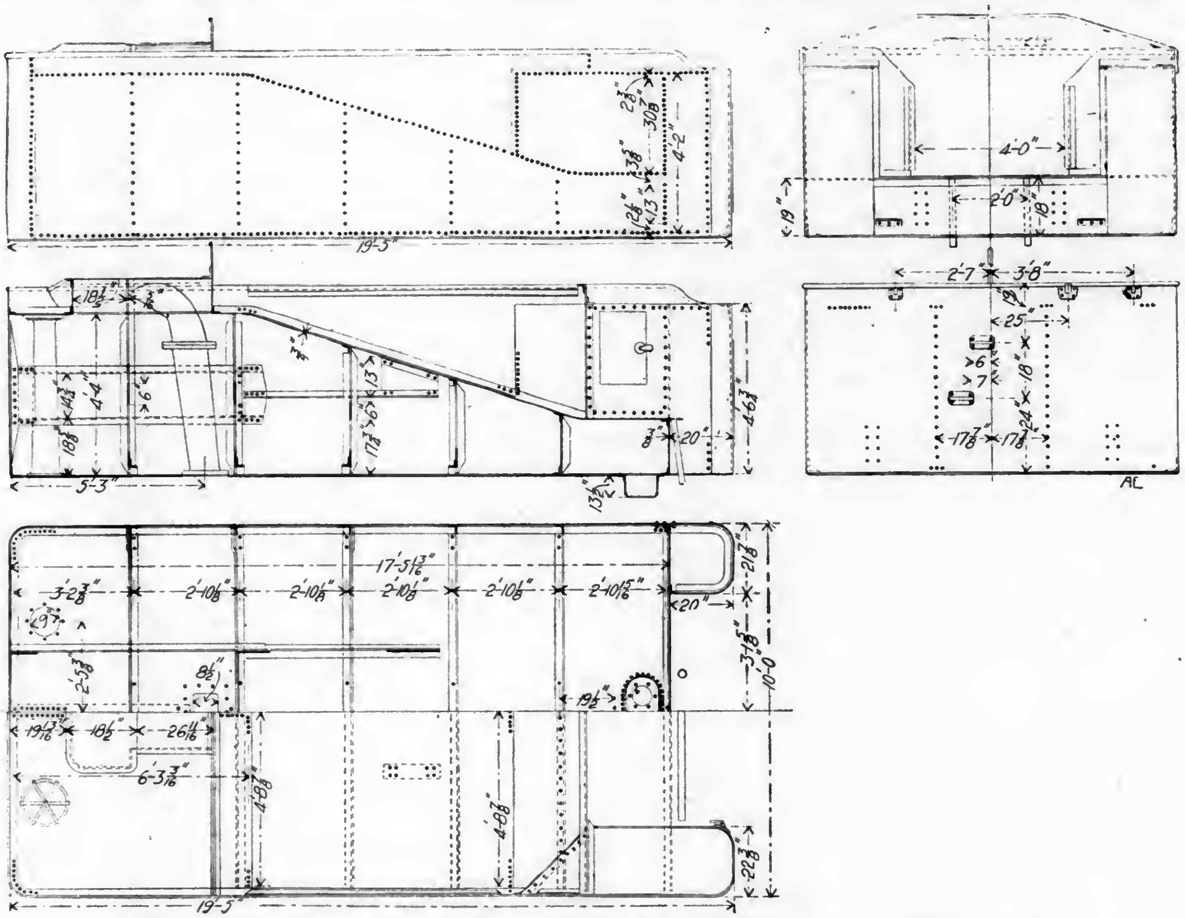


Fig. 10.—Sectional Views of Tender Tank for Class E 1 Engines, Pennsylvania Railroad.

of 68 miles per hour. The following figures have been supplied from tests made with one of these tenders:

Time in seconds.	Speed in m. p. h.	Gallons water taken.	Dip of scoop in water.
20	34	1,760	3⅛ in.
17	40	2,315	3 in.
14	49	2,380	3⅛ in.
11	62	2,608	3 in.

These figures show that more water was raised per foot of trough at the higher than at the lower speeds, which is accounted for by the form of the opening which takes in the wave raised by the scoop and adds to the depth of water taken. These tests indicate that there should be no difficulty in picking up 3,000 gallons from a tank 400 yards long at speeds of 60 miles per hour.

An Atlantic liner, larger than any now afloat, has been ordered by the North German Lloyd, to be built by the Vulcan Shipbuilding Company of Stettin, Germany. It is rumored that her length will be 752 ft., her speed 24 knots, and that her engines will develop 40,000 h.-p.

A lathe, direct driven by an electric motor, turning up a piece of shafting while the whole combination was suspended from an electric traveling crane, was exhibited to a party of engineers visiting the Crocker-Wheeler Electric Company's works recently. This ingenious application of electricity to machine tools was devised to exhibit the flexibility of the electric method of power distribution and was described in "The Mechanical Engineer." The lathe had a motor direct connected to the spindle and the piece of shafting was placed in the centers. The electric current was applied by a cable connected to the traveling crane. The current was applied, the lathe started on the floor and then lifted by the crane and carried up and down the shop while turning up the shaft.

THE FUTURE USEFULNESS OF THE MASTER MECHANICS' ASSOCIATION.

By M. N. Forney.

It is very difficult for an old newspaper man to lay off the spirit of cock-sure criticism. The habit of assuming for years that he is very wise and very right in his opinions cannot be laid aside when his editorial pencil has been blunted, and when he no longer has the right to speak of himself as "we." Annual conventions like those which have just been held in Saratoga are incentives to be oracular, they excite criticism and stimulate the feeling common to most of us, that we know just a little better than others how such affairs should be conducted. If besides the conventions of this year a person can go back for thirty years and recall the meeting held in Philadelphia in 1870, and nearly all since then, it is a still further incentive to criticism and suggestion.

The fact that a committee was appointed to report on the question of "What Can the Master Mechanics' Association Do to Increase its Usefulness?" naturally suggests two questions, what have been the hindrances to the usefulness in the past and what would aid in increasing it in the future? The retrospect of thirty years will be a help in replying to the first part of the inquiry, and it suggests two causes which during that time have seriously interfered with the usefulness of the meetings. The first of them is meeting rooms in which only part of the proceedings could be heard, owing to noise or bad acoustic properties, or an arrangement of seats by which the audience and the speaker have been separated too far from each other. To hold meetings for discussion at which the speakers cannot be heard seems like great folly; nevertheless, it has happened at many of these meetings held during the past thirty years that a great part of the proceedings were inaudible to many of those who attended them. To increase their use-

fulness, therefore, it is important first to secure a good room to meet in, which should not be too large, and in which not only speakers on the platform can be heard by the audience, but those in the auditorium can be heard by the whole house. The people and hotel proprietors of Saratoga seem to be anxious to induce not only the Master Mechanics' and Master Car Builders' to hold their meetings there every year, but they also want to induce other associations to do the same thing. There is hardly anything which would do so much to attract such organizations to meet there as a really good room would if it was well adapted for such meetings. It should not be too large—a seating capacity of three or four hundred would be sufficient—and it should be located where there would be little or no external noise, as from the street. In the middle of Congress Spring Park would be an ideal place for it. The seats should be arranged in the form of a horseshoe around a central platform and on an inclined floor as in a theatre, so that the people in the audience would be brought into close relation to the chairman and to each other. There should be two small committee rooms. The ceiling should not be too high on account of acoustic properties. Such a room would be a great boon to associations whose meetings are attended by a comparatively small number of people. The Convention Hall in Saratoga is entirely too large for such audiences, and the voices of their speakers are lost in it. Will the people of Saratoga respond to this demand? There is a disposition to hold the meetings of the two railroad associations there every year. A really good meeting room would add very much to the inducements to take them there.

In speaking of the second hindrance to the usefulness of these associations, a disavowal is made of any personal reference to any one. What will be said is the result of historical reminiscence, extending backward thirty years, and candor compels the remark that during that time the presidents of the associations, as presiding officers, have been good, bad and indifferent. The good ones have been few, the bad and indifferent ones many. In other words the proceedings and the work of the associations has been very much hindered by having inexperienced presiding officers. Some of us can recall occasions when the proceedings were snarled into such an inextricable tangle that the work came to a standstill. That those who preside should not be very efficient in such duties is not to be wondered at, very few of the members have ever had any experience as presiding officers. The presidents are not chosen with reference to their capacity for such duties, but they are elected to the office as a recognition of merits which are of quite a different kind, and they are elevated to the office as an honor, and the position is so regarded. Now, it is of as much relative importance that meetings of this kind should be under efficient and intelligent control as that a regiment in going into action should be directed by a competent commander, or that a locomotive in running an express train should be in charge of skillful runners. Amateurs and inexperienced people are not intrusted with such duties and there is quite as good reason for not placing the conduct of such meetings of this kind under the control of persons who know little of parliamentary proceedings, or who have not the knowledge and tact to call out what is best in the minds of the auditors.

These considerations lead to the suggestion of separating to some extent the honors of the president and the duties of the presiding officer. Honor the member by electing him president and then let the Executive Committee appoint an assistant to that officer who would be selected solely with reference to his capacity as a presiding officer. The president would then open the meeting, deliver the annual address and perform like duties, but his assistant could at any time take his place as presiding officer, and that would leave the president free to attend to other important duties during the session, instead of, as now, tying him down in the chair all the time. There are many things which could profitably be attended to by the president during the session, such as seeing committees, aiding and directing the preparation of reports, shaping in different ways the work and policy of the Association, etc. If it was desired to accentuate the honor, a suitable badge could be provided and a title conferred.

In the light of past experience it is safe to say that the usefulness of the meetings would be immensely increased if they were presided over by thoroughly efficient chairmen.

Another suggestion presents itself. The purpose of the reports made to these meetings and the discussions thereon is to elicit from the members as much information as possible in relation to the subjects which are brought up for consideration. The method of doing this is by circulars of inquiry, and then when the matter comes before the meetings by a general discussion. While these methods accomplish their purpose, to a certain extent, it is thought that a much more effective way of getting at the knowledge of other people is by an interview and questioning them with reference to the subject under consideration. It is the method adopted in courts of justice, in the investigations of committees of various kinds and in our daily life and intercourse with other people. The suggestion is that the various committees of investigation should, during the session of the convention, invite different members to appear before them to confer about the question at issue, and in that way give the members of the committee an opportunity to question those who are thus invited. That is the method we all adopt when we want to get information relating to any matter, and it would seem as though it would be equally efficacious in the investigation of committees.

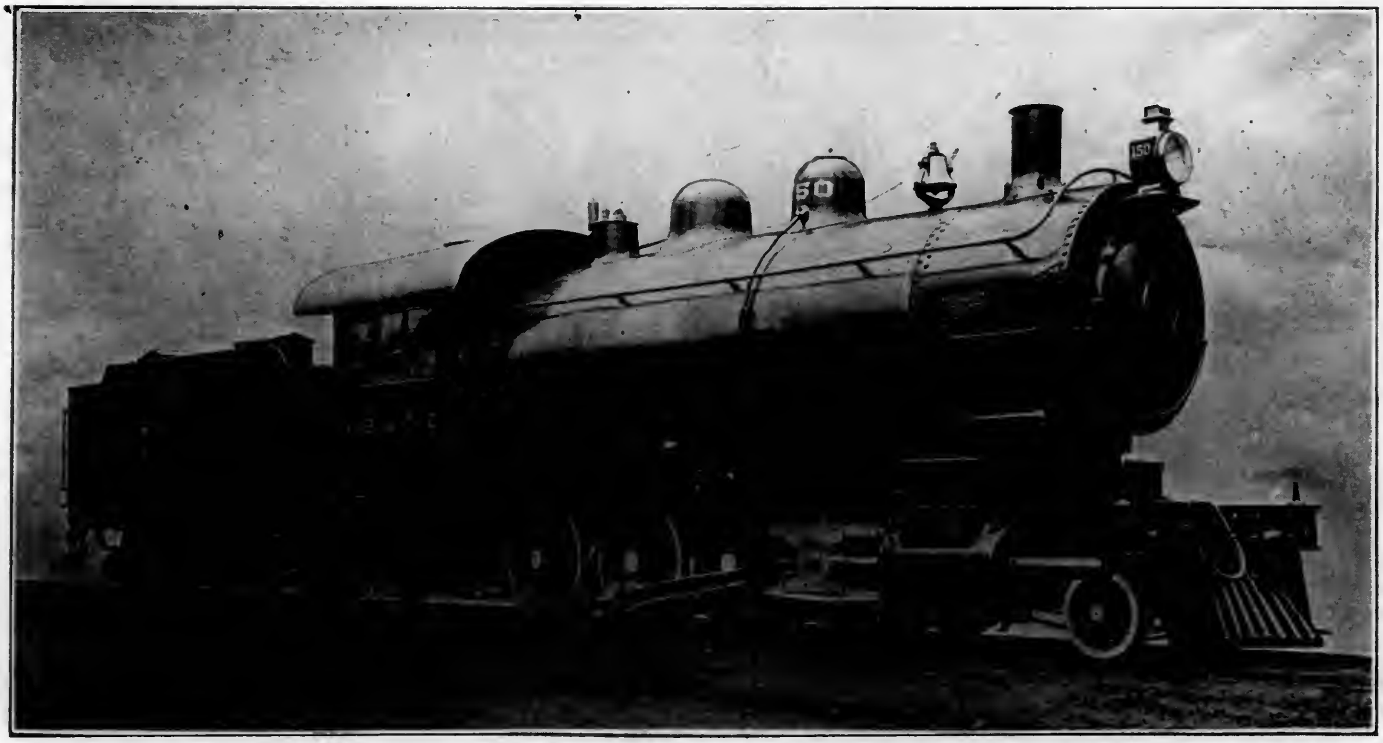
The question of indexing the reports of the Association was brought up, and acted upon, and the committee was authorized to have a comprehensive index made of all the reports of the Association up to date, which will certainly increase their value very much. The past volumes have very poor indexes, and it would be very desirable to take some action which would secure better ones in the current volumes in the future.

One of the great difficulties at the meetings of these associations, which are now attended by from 1,500 to 1,800 people, to remember the names of those who are there and identify them on sight. The method adopted by the American Society of Mechanical Engineers at their meetings is a very good one. A list of the members in attendance is prepared and numbered. Numbered badges are then provided for the members, and the list and numbers are printed and copies distributed so that in meeting a person his number is a clue to his name. It facilitates intercourse very much and promotes sociability.

Of course, after all the reports of committees the discussions at the meetings and, in fact, the value of the whole proceedings, depends very largely on the persons who contribute to them. The problem is to call out what is best among the members and suppress the vapid talkers—not always an easy task. If all the members were intelligent and wise, of course the meetings would be more profitable and interesting. Inasmuch as the membership consists of many grades of intelligence and fatuity the problem is to get the best that is possible out of the material and the people who come annually to these assemblages.

Mr. A. L. Humphrey, Superintendent of Motive Power of the Colorado Midland, has been appointed to a like office on the Colorado & Southern, vice John Foster, resigned. Mr. Humphrey has been Superintendent of Motive Power of the Colorado Midland since January, 1893, and was formerly for five years Master Mechanic of the same road.

Mr. C. W. Whiting, Mechanical Engineer of the E. P. Allis Company, Milwaukee, Wis., has been appointed Mechanical Engineer of the Chicago, Milwaukee & St. Paul at West Milwaukee, Wis. Mr. Whiting is 37 years of age, is a graduate of Stevens Institute in the class of 1884, and has since been draftsman with the Philadelphia & Reading Coal and Iron Company at Pottsville, Pa.; has held the responsible position of Inspector and Engineer of Tests, Chief Draftsman, Superintendent and Mechanical Engineer with various firms.



Another Monster Freight Locomotive; Pittsburgh, Bessemer & Lake Erie Railroad.

E. B. GILBERT, *Master Mechani .* — PITTSBURGH LOCOMOTIVE WORKS, *Builders.*

ANOTHER MONSTER CONSOLIDATION LOCOMOTIVE.

Pittsburg, Bessemer & Lake Erie R. R.

Built by the Pittsburg Locomotive Works.

This locomotive surpasses in weight and tractive power all locomotives ever built and its remarkable dimensions are given in the accompanying table. The information reaches us too late for extended comment, but this is not necessary to those who will compare it with the large engines referred to in the table on page 316 of our issue of October of last year. These engines are remarkably heavy and are large in every way, except in grate area, as the table of detail dimensions indicates. Two of these engines have been built by the Pittsburg Locomotive Works and are now in service. It now seems impossible that these dimensions will be exceeded, but the progress of the past two years has been so remarkable in this direction that we shall not prophesy as to the future. An 84-in. boiler, 220 lbs. steam pressure and 24 by 32 in.-cylinder certainly constitute an impressive combination, the effect of which is seen in the immense tractive power of 63,000 lbs. The chief dimensions, including those of the very large tender, are as follows:

General Description.

Gauge of track	4 ft. 8½ in.
Kind of fuel used	Bituminous coal
Weight on drivers	225,200 lbs.
Weight on truck wheels	25,100 lbs.
Weight, total	250,300 lbs.
Weight of tender, loaded	141,100 lbs.
Weight, total of engine and tender	391,400 lbs.

Dimensions.

Wheel base, total of engine	24 ft. 4 in.
Wheel base, driving	15 ft. 7 in.
Wheel base, total of engine and tender	57 ft. 11¾ in.
Length over all, engine	41 ft. 1½ in.
Length over all, total, engine and tender	68 ft. 0 in.
Height, center of boiler above rails	9 ft. 8 in.
Height of stack above rails	16 ft. 0 in.
Heating surface, firebox	241 sq. ft.
Heating surface, tubes	3,564 sq. ft.
Heating surface, total	3,805 sq. ft.
Grate area	36.8 sq. ft.

Wheels and Journals.

Drivers, diameter	54 in.
Drivers, material; front, intermediate and back centers	Steeled cast iron
Drivers, material, main centers	Cast steel
Truck wheels, diameter	30 in.
Journals, driving, front, intermediate and back	9 by 13 in.
Journals, driving, main	10 by 13 in.
Journals, engine truck	6 by 12 in.
Main crank pin, size	7½ by 8 in.

Cylinders.

Cylinders, diameter	24 in.
Pistons, stroke	32 in.
Piston rods, diameter	4½ in.
Piston rod and valve stem packing	Metallic
Main rod, length, center to center	118⅝ in.
Steam ports, length	20 in.
Steam ports, width	1⅝ in.
Exhaust ports, length	20 in.
Exhaust ports, width	2¼ in.
Bridge, width	1½ in.

Valves.

Valves	Balanced
Valves, greatest travel	8 in.
Valves, outside lap	1 in.
Valves, inside lap or clearance	0 in.
Valves, lead in full gear	1-10 in.

Boiler.

Boiler, type of	Straight with sloping back end
Boiler, water test	330 lbs.
Boiler, steam test	240 lbs.
Boiler, working pressure	220 lbs.
Boiler, material in barrel	Carnegie steel
Boiler, material in barrel, thickness	1 in.
Boiler, diameter of barrel at front sheet	84 in.
Boiler, diameter of barrel at throat sheet	88 in.
Boiler, diameter of barrel at back head	81½ in.
Seams, kind of	Horizontal, butt joint, double welted sextuple riveted
Seams, kind of	Circumferential, double riveted
Thickness of tube sheet	⅝ in.
Dome, diameter	32 in.
Safety valves	Two 3-in. open pops and one muffler
Water supplied through	Two No. 12 injectors
Crown sheet supported by	Radial stays

Tubes.

Tubes, number	406
Tubes, diameter outside	2¼ in.
Tubes, length over tube sheets	15 ft. 0 in.
Tubes, material	Solid drawn steel

Firebox.

Firebox, length	132 in.
Firebox, width	40¼ in.
Firebox, depth at front end	82⅞ in.
Firebox, depth at back end	70⅞ in.
Firebox, material	Carnegie firebox steel
Firebox, thickness of sheets, crown	7-16 in.
Firebox, thickness of sheets, sides and back	⅜ in.
Firebox, thickness of sheets, tube	½ in.
Firebox, water space, width	front 4 in., back 4 in., sides 4 in.
Grates	Cast iron, rocking pattern

Smokebox.

Smokebox, diameter	83¼ in.
Smokebox, length from tube sheet to end	68⅝ in.

Other Parts.

Exhaust nozzle	Single
Exhaust nozzle, diameter	5¾ in.
Smoke stack	Taper
Smoke stack, least diameter	17 in.
Smoke stack, greatest diameter	18 in.
Smoke stack, height above smoke box	33 in.
Track sander	Pneumatic
Power brakes	Westinghouse American

Tender.

Type	Eight-wheeled, with swivel trucks
Tank capacity, water	7,500 gal.
Tank capacity, coal	14 tons
Kind of material in tank	Steel
Type of under frame	Steel channels
Type of truck	Diamond
Type of truck springs	Double elliptic
Diameter of truck wheels	33 in.
Diameter and length of axle journal	5½x10 in.
Distance between centers of journals	77 in.
Diameter of wheel fit on axle	6⅞ in.
Diameter of center of axle	5⅞ in.
Length of tender frame over bumpers	25 ft. 0 in.
Length of tank	23 ft. 6½ in.
Width of tank	9 ft. 10½ in.
Height of tank, not including collar	65 in.
Height of tank, including collar	81 in.
Type of back drawhead,	M. C. B. coupler and Westinghonse friction draft gear

A table with some interesting comparative figures, including these engines, is given below:

Railroad	P. B. & L. E.	Union R. R.	Illinois Central.	Lehigh Valley.
Builders	Pittsburgh.	Pittsburgh.	Brooks	Baldwin.
Size of cylinders	24 x 32 in.	23 x 32 in.	23 x 30 in.	18 & 30 x 30 in.
Total weight	220,300 lbs.	230,000 lbs.	232,200 lbs.	225,082 lbs.
Weight on drivers	225 200 "	208,000 "	193,200 "	202,232 "
Total weight of engine and tender	391,400 "	334,000 "	364,900 "	346,000 "
Tractive pow. r based on 25% of adhesive weight	56,300 "	52,000 "	48 300 "	50,558 "
Net hauling capacity on level	7 847 tons.	7,261 tons.	6,717 tons.	7.049 tons.
Comparison of hauling capacity	100%	92 5%	85.6%	89.8%

MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

This society opened its 41st meeting in Cincinnati, May 15. The first professional paper, by H. T. Yaryan, dealt with hot-water heating from a central electric light station and began with the remark that "it does not require the eye of a prophet to foresee the future means of heating and lighting our cities." It gave a good description of a system now in use in a number of cities whereby the by-product sale of heat in the form of hot water was satisfactorily profitable. Water at a temperature not over 212 degrees was circulated in pipes at a pressure of 60 or 70 lbs. The details were fully presented, also the advantages of hot water over steam circulation. The demand for heat was so much greater than that for light that electricity was really the by-product. Experience had shown that every dwelling house heated required the exhaust from engines necessary to light four. The paper describes an apparently practicable and successful system.

Systems and efficiency of electric transmission in shops were discussed in a paper by William S. Aldrich, which compared various power transmission systems and made clear the advantages of scope in electric systems. The induction motor received the following endorsement:

"The induction machine as it stands to-day is probably the most perfect motor yet developed from the standpoint of electric transmission in factories and mills. It may be started and operated from any point, at any time, at practically any load and speed within its predetermined ranges. It will permit of higher lineal speeds than are possible with any other type and cannot be burned out from rough usage and overloads. This makes the induction motor specially fitted for driving almost all classes of shop machinery."

As a result of litigation in Massachusetts concerning damage claims for water privileges, Mr. George I. Rockwood at the previous meeting introduced the question of the proper method of computing the value of a horse-power, and as the discussion was not conclusive, it was reviewed at this meeting, but was again left without definite action. In a paper on the design of speed cones, Mr. James J. Quest offered a new method for obtaining the sizes of cone pulleys in which the "cut and try" process was elminated. Reheaters in multiple cylinder engines were shown in a paper by Dr. Thurston to be the means of securing a small gain, but the author stated that "unless the reheater is made effective in superheating, it is better not to employ it at all."

A six-day test on a 15,000,000 high-duty Nordberg pumping engine was recorded in a paper by Messrs. Cooley, Wagner and Allen, in which the average steam consumption for the six days' run was 12.7 lbs. per horse-power hour. This paper was followed by one by Prof. Goss describing his noteworthy tests of the Snow pumping engine of the Indianapolis Water Company, conducted in 1898. This engine had, at the time of the test, the best record for economy.

Superheaters have been improved so much during the past few years as to justify the expectation that they will constitute one of the leading factors in the improvement of steam engine economy in the immediate future. An application to a Worthington pump at the water works of St. Albans, England, was described in Mr. E. H. Foster's paper. This plant was not a refined, up-to-date establishment, but an ordinary Worthington "low duty" installation, with two Lancashire boilers of the two-flue type, each boiler having a Schwoerer superheater with 60 sq. ft. of external heating surface. The piping was arranged to use or cut out the superheaters at will. The pumps indicated about 100 horse-power in the tests, and the advantage in duty between saturated steam and steam superheated to 125 degrees was about 16 per cent. Corliss was shrewd in his use of superheated steam, and it is clear that years ago he appreciated its value.

Mr. B. C. Ball set many thinking about the question of "drop" in multiple-expansion engines by his paper on cylinder proportions for compound and triple-expansion engines. He favors "drop" and shows, we think, conclusively that it is desirable because of its effect in reduction in the proportion of internal condensation compared with the total amount of steam used, the condensation being nearly a fixed amount per stroke for given conditions, and by throwing away some work by free expansion at each end of the stroke a gain is found. This is because the total amount of work done is increased while the condensation, which is a total loss, becomes a smaller proportion of the steam used. The author agrees with Mr. George I. Rockwood in believing terminal drop beneficial, although this is contrary to the generally accepted opinion.

Of the remaining papers the most important were "Water Softening Plant at the Lorain Steel Company's Blast Furnaces," by N. O. Goldsmith; "The Automobile Wagon for Heavy Duty," and "Education of Machinist Foremen and Mechanical Engineers," by M. P. Higgins. We shall refer to the paper by Mr. Goldsmith in a future issue. The paper on automobiles brought out a marked preference for steam as a motive power for heavy wagons.

The attendance was good, but the discussions were very disappointing.

Mr. Henry W. Toothe, who has represented the Midvale Steel Company for the past eleven years and has been well and faforably known in the railroad supply business for twenty years, has severed his connection with that company and accepted the position of representative of the Chicago Pneumatic Tool Company, July 1, with headquarters in Denver. He will have charge of their interests in Colorado, Wyoming, Idaho and the mining districts generally and will bring to bear a very unusually wide acquaintance and valuable experience. We congratulate Mr. Toothe and the Chicago Pneumatic Tool Company upon this consummation. He is sure to enjoy a large measure of success, and we think that the company could not find a better representative.

THE AMERICAN BALANCE PISTON VALVE.

One of the most interesting and promising improvements in piston valves has just been developed by the American Balance Valve Company, and is about to be tried on the Chicago & Northwestern Railway. The object is to combine the desirable features of the plug valve with facilities for automatic adjustment to the bore of the valve chamber, to obtain ample bearing surface of the packing rings by use of wide rings with absolute protection against excessive friction caused by steam pressure against the inside of the rings, and to do this with simple and durable devices. We have not in a long time seen such a neat mechanical design in connection with valves.

The improvement was developed by Mr. J. T. Wilson of the

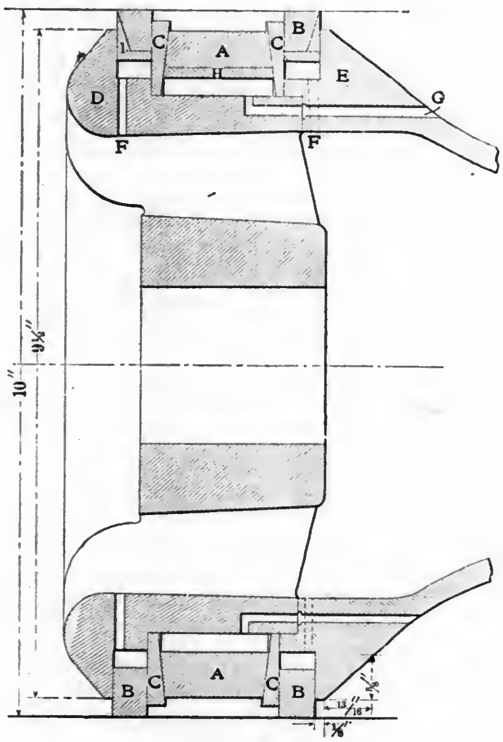


Fig. 1

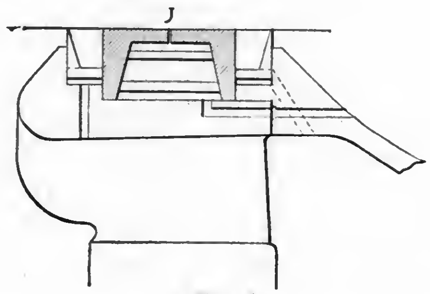


Fig. 4

American Balance Valve Company. In Fig. 1 a form of packing is shown from which the idea was developed. In it the parts are lettered for reference. Fig. 2 is the application for the Chicago & Northwestern Railway. (A valve of this form attracted a great deal of attention at the Master Mechanics' Association convention in Saratoga last month.) Fig. 3 is an arrangement of the same elements for the Brooks Locomotive Works, and Fig. 4 is another form of Fig. 1, to meet the views of those who favor narrow rings. The idea in all of these is that of the beveled ring, which has been used for a number of years in the disc balance of this company, but employed in this case to produce wedging action on the packing rings and to secure steam-tight joints to keep the steam from getting under the packing rings.

In Fig. 1, A is a wedge ring under which boiler steam is admitted through the ports, G. This ring has ground joints with the solid rings, C, which may be made with or without flanges. The snap rings, B, may be made of any form or size, and these are wedged tight against the valve spool, E, and the follower, D, by the steam pressure inside of the ring, A. The spaces under the snap rings, B, are vented to the exhaust so that pressure can not accumulate under them. The rings are put under tension and turned on their outside diameter, so as to be perfectly cylindrical and true with the valve casings when placed in position. They are elastic and tend at all times to expand to fit the casing. When the throttle is closed the parts are free

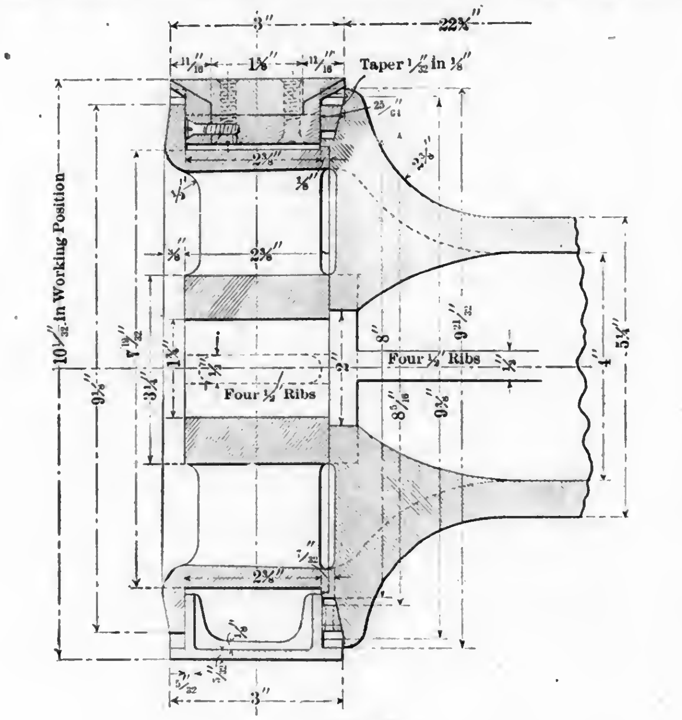


Fig. 2

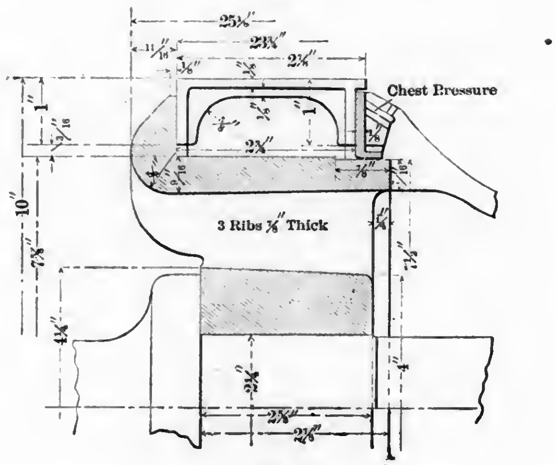


Fig. 3

to adjust themselves to fit the casing, and when steam is admitted to the chest and to the center of the valve the wedge rings act at once to lock the packing rings in position, which produces essentially a plug valve as long as the pressure is on. The principle of Fig. 1 is used in the other forms illustrated. In the two designs for trial the valves are arranged for internal admission, but the parts may be reversed for outside admission.

These valves have continuous steam and exhaust lines because the rings are tapered at the joints and the joint plates

are tapered to fit the tapers of the rings at the joints. The steam-tight joints are made by the taper ring, which is easily ground to fit the face of the packing ring and the seat on the end of the valve spool. The arrangement is very simple, and the taper ring, being inside the flange of the packing ring, is protected, and it can not fall out even if it should break, which is not likely to happen.

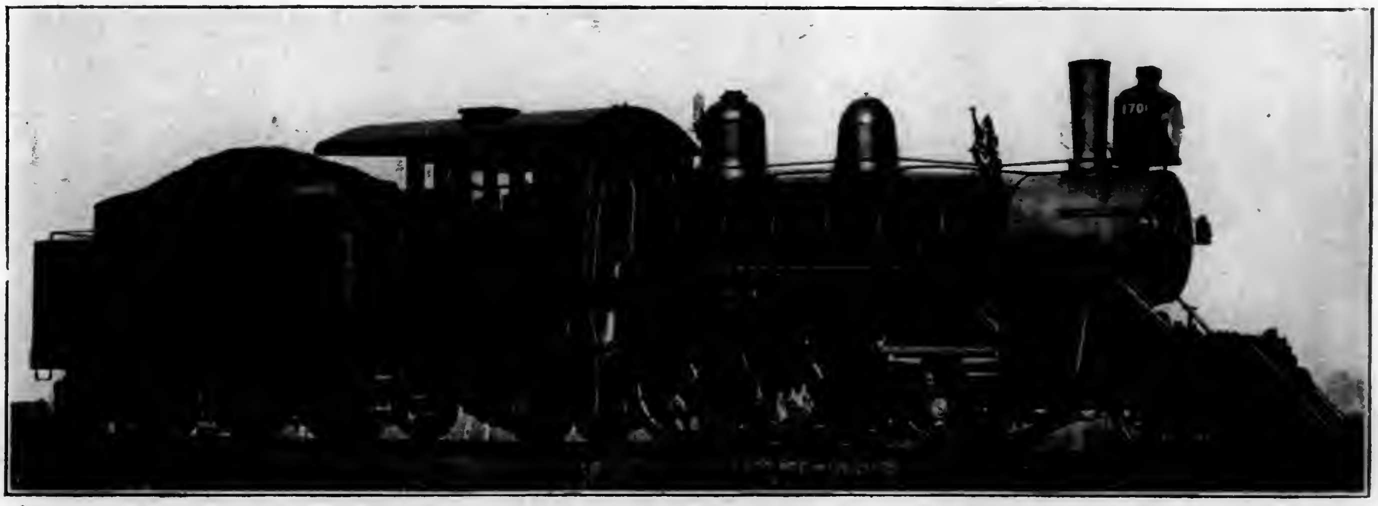
It will be seen at a glance that the packing rings offer a sharp cutting-off edge which will not tend to disturb the direct current of the steam, which has occurred with some valves in which the controlling edge was back some distance from the end of the valve. There is every reason to expect this improvement to overcome the difficulties which have been found in several applications of wide packing rings, and we consider this a very promising and important improvement.

PRAIRIE TYPE, WIDE FIREBOX LOCOMOTIVE.

Chicago, Burlington & Quincy Railroad.

Through the courtesy of Mr. F. A. Delano, Superintendent of Motive Power of the Chicago, Burlington & Quincy Railroad, a photograph of the new "Prairie Type" locomotive recently built by that road has been received. This engraving supplements the description of the engine printed in the April number of this journal, page 103.

Satisfactory service is reported for these engines and we are informed that the expectations of the designers are realized. In a short time we expect to be able to give definite information as to their performance.



Prairie Type, Wide Firebox Locomotive, C. B. & Q. Railroad.

The American Railway Asssociation Committee on Safety Appliances reported that on January 1, 1900, out of 1,283,679 freight cars in service, 1,191,189 (92.8 per cent.) were fitted with automatic couplers and 318,180 (63.7 per cent.) were fitted with air brakes. Also, that out of 34,319 engines reported, 33,435 (97.4 per cent.) were equipped with power brakes. New cars to the number of 102,485, under construction January 1, 1900, were all to be fitted with automatic couplers and air brakes.

CASE-HARDENING MATERIAL.

A chemical mixture for hardening in furnace heat has been introduced by some of the largest ball and roller-bearing tool and machinery manufacturers, and is said to be preferable to any other material now in use. It is claimed that "Carburizer," manufactured by the American Carburizing Company, 160 Pearl street, New York, will harden steel to a greater depth of fileproof surface, with tough interior, than granulated bone, and in about half the time required by that material. Articles hardened with Carburizer will turn out smooth. Carburizer is about 30 per cent. cheaper than bone, because of its lighter weight.

THE CLEVELAND LOCOMOTIVE.

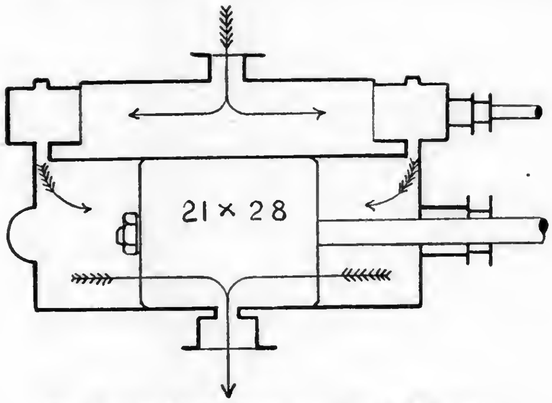
The description of the Cleveland locomotive cylinder on page 146 of our issue of May called forth the following communications. Mr. Cleveland's is published in full, but without endorsement. We can not follow him in the mysterious interchange of heat which he describes, but we desire to be perfectly fair to his engine. The dual exhaust seems to be an admirable device for reducing cylinder condensation, for the reasons which we have already stated, and it has the important attribute of simplicity, but this advantage is somewhat offset by the increase in weight. We do not consider the tests referred to as conclusive. They point to the desirability of further tests and continued service trials. Mr. Todd seems to have stated the case for the dual exhaust clearly and there appears to be something in it.—Editor.

To the Editor:

I have read with much interest your article, on pages 146 and 147 ante, describing the Cleveland dual-exhaust cylinders on the Intercolonial Railway of Canada; and would beg to point out that their economical action can be still further improved by making the elongated piston a light continuous shell, as shown on the accompanying diagram, instead of two separate narrow pistons, as you illustrate. The exhaust steam may be 150 degrees colder than that in the boiler, and it is therefore a thermodynamic mistake to allow it to have continuous access to the interior of the hot cylinder, in the space between the pistons.

Instead of the two central escape ports in the Cleveland cylinder, there should be only one, as on the diagram. The width of this should be one-tenth of the stroke, and the cylinder will then automatically exhaust at 90 per cent. of each stroke, quite irrespective of the working of the slide valve, even although it should be hooked-up right to the center. These central ports should be made with very ample area, leading into a large exhaust pipe carried from the bottom of the cylinder below the frame and then turning upward into the stack. This will leave very little of the cold residual steam to be expelled through the hot steam inlet port, and will also completely drain the cylinder without the use of special cocks. And if lap should be given to the exhaust side of the valve to lessen the time during which the cold exhaust has access to the hot interior of the cylinder, and also to prevent a too early release, it will not, if used in moderation, produce any choking from the small amount of residual imprisoned steam.

The Corliss cylinder, with its separate steam valve at the top and its separate exhaust valve at the bottom, was an advance on previous practice, as it prevented, to some extent, the cooling of the hot steam inlet by the cold waste steam, and also effectually drained the cylinder. And it is evident that the terminal-exhaust plan of getting rid of the greater part of the cold waste steam without allowing it to return to cool the



Mr. Todd's Suggestion for "Dual Exhaust."

initial end of the cylinder, where the hot boiler steam has to enter for the following stroke, is yet still a large step in advance of the benefits originated by Corliss; and this without any complication caused by the use of separate exhaust valves or additional mechanism.

In order to determine the precise advantages of this system I made a special experimental cylinder 6 ins. in diameter, and afterward another 10 ins. in diameter. These were fitted with cocks to shut off the central exhaust when required, and also with surface condenser and scales on which to weigh the condensed steam, and were supplied with steam at 160 lbs. by a locomotive boiler. With these many experiments were made, from which the following general results have been deduced:

(1) As the greater part of the cold waste steam is got rid of without being allowed to return and cool the hot inlet end of the stroke, therefore the inlet end of the cylinder is not cooled as much as usual; and therefore less steam than usual is required to fill the cylinder up to the point of cut-off.

(2) On account of this reduction of initial condensation, the steam pressure at the top side of the diagram starts several pounds higher than in an ordinary cylinder with the same boiler pressure; and on account, also, of the initial end of the cylinder being hotter than usual, the whole top side of the diagram is considerably higher than in ordinary cylinders working with the same pressure in the boiler.

(3) On account of the very large and free escape for the waste steam, which remains constant and quite unaffected by the slide valve motion, the bottom side of the diagram is always much lower than in any ordinary cylinder.

(4) Therefore, as less steam is used per stroke; as the top side of the diagram is higher, and as the bottom side of the diagram is lower, the dual-exhaust cylinder gives more diagram area or power, per pound of steam supplied from the boiler, than can be obtained from an ordinary cylinder, which releases all its cold waste steam from the initial end of the stroke.

Finally, the dual-exhaust cylinder is much more economical than usual; it is quite unapproachable for quickly getting rid of its waste steam; it has no more working parts than an ordinary engine; and hence, is an ideal cylinder (when properly proportioned and put to work) for fast running.

I beg to congratulate Messrs. Cleveland on their success so far, and hope to hear of still further advances in the future.

LEONARD J. TODD.

97 Queen Victoria Street, London, England.

To the Editor:

The article published in the May number of The American Engineer, on the Cleveland locomotive, is far from accurate in its attempted description of the distinguishing features of this invention, and equally erroneous in its alleged exposition of the principles which underlie its established economy in steam consumption. It is not desired in this paper to give any avoidable offence to the author, whose article seems to have been written in a friendly and unprejudiced spirit; but it would have been wise on his part to have first informed himself, by careful study and observation, since he has chosen to ignore the present views of both inventors.

The Todd locomotive, described in a previous issue, and cited as an experiment, analogous to those conducted on the Intercolonial Railway during the past three years, has really only a limited resemblance in design, and no bearing whatever on the main economic principles tested in the Cleveland locomotive. The single central exhaust port of the Todd locomotive has been the subject of many experiments, and for many years abandoned, from which we naturally infer that the results obtained gave little or no encouragement to the promoters. Aside from a possible reduction in back pressure and compression, it is difficult to discover a reason why these experiments should have terminated otherwise. The main piston and supplementary exhaust ports must necessarily open at about the same time, so that the advantages claimed for separate induction and exhaust ports are out of the question, and especially as the final exhaust, at a lower pressure and temperature, is discharged through the admission ports in the ordinary way. The rapid initial exhaust, due to the large port areas, should give a lower exhaust line and reduced compression, but why a saving in cylinder condensation should be claimed for the same reason is not so apparent. The greater capacity of the cylinder spaces, exposed for this reason for a longer time to a lower exhaust temperature, must inevitably give a contrary result, and the failure of the experiments should be attributed chiefly to this cause.

All the evil causes of cylinder condensation in the standard locomotive are retained, in an aggravated form, in this engine. It is claimed that better drainage is obtained by the use of the central exhaust port, but this advantage is only appreciable when the cylinders are cold, and the engine standing or moving slowly. In the standard engine it is the film of water clinging to the cylinder walls, or saturating the material available for compression and swept by the piston into the clearance spaces, that is the primary cause of condensation, which is also true of the Todd engine, but to a greater extent, for the reasons specified. The central exhaust port, being separated from the clearance spaces by the entire length of the stroke, affords no relief from this evil.

If water should pass the admission ports in sufficient quantity to separate from the steam, and gather on the bottom of the cylinder, or if condensation should become so bad as to effect the same result, a measure of relief would be afforded by the central exhaust port; but an engine in which such conditions continuously prevail would prove very economical as an addition to the scrap heap. If cylinder condensation is to be avoided, the walls and piston must be kept dry and the aqueous residue of out-worked steam removed, thus enabling the iron to accumulate the full initial temperature of the steam and at the same time explode the absurd fallacy that it can be made to accumulate or part with such a temperature in a fraction of a second. It is strange that engineers will cling to such a nonsensical theory as this, when the enormous heat-absorbing capacity of aqueous vapor is well known.

When saturated steam is instantaneously expanded from one chamber to another without doing work, as in the Cleveland cylinder, it becomes dry steam at a lower pressure, and thus also the film of water is re-evaporated from the walls and piston at every exhaust and a dry hot cylinder obtained after a few revolutions. Although there are other advantages which may be justly claimed for this improvement, they are chiefly tributary to this one or follow as effects of this primary cause of the engine's economy and success.

In future designs it is intended to further expand the exhaust by also discharging it through a direct channel into the central chamber of the opposite cylinder, whose pistons at the point of release are about at half stroke. This plan has been partially tested by changing the construction of the exhaust pipe of one of the engines now in use, but not to the fullest advantage, as the passages are not direct and entail unnecessary changes in the current of the steam before its final discharge through the nozzle. A very marked improvement in coal consumption, however, was at once obtained, which is conclusive proof, if such is required, of the soundness of this theory of exhaust expansion.

It is also intended to use annular induction ports instead of the common bridged ports, the bridges being unnecessary as the packing rings will then be wider than the ports. The ports through the valve sleeves will be narrower and of less aggregate area than would be admissible in the standard cylinder, no provision being here necessary for the discharge of the initial exhaust; but a greater area, owing to the absence of the bridges, will be obtained for the final exhaust, which the

higher piston speed at this part of the stroke renders desirable. The extent to which the aggregate port areas of the sleeves may be reduced without in any way diminishing the effective admission capacity will be recognized when it is considered that valve port openings of only ⅝ inch can be obtained in the largest locomotives at half-stroke cut-off. As the piston speed is always low with late cut-offs, the change in the port construction will then be immaterial, although the aggregate or effective port area will be less. The bridges reduce the effective port area, add to the initial fractional losses, and afford no protection from damage to the cylinder by small pieces of broken packing rings. Annular exhaust ports and wider piston packing rings are used in both the Cleveland engines, and give remarkable freedom from uneven wear and broken packing rings.

It is necessary to further explain the reference to "pockets for the accumulation of water." Water could not gather in the enlarged central portion of the cylinder, whether the ribs holding the section between the ports are placed as shown in the illustrations, or whether they are placed, as in the first Cleveland locomotive, in a single row in the center of the cylinder enlargement. The latter construction is preferable, as the exhaust port area is not reduced by the ribs. The main consideration in designing this portion of the cylinder is to provide ample area for the instantaneous expansion of the primary exhaust. The initial discharge is more rapid than desirable, and will draught the fires more efficiently when prolonged by expansion into the larger spaces of both exhaust chambers. These spaces will then be almost continuously subjected to the drying action of the exhaust expansion, so that the possibility of "water accumulations" will become still more remote.

During the admission periods a number of heat units are consumed in proportion to the work performed, or the loss by condensation sustained, but as the boiler is a continual source of supply until the port is closed the pressure is maintained so far as the port area and piston speed will allow. The effective pressure during this period has one source of maintenance, which is the entire volume of heat units stored in the steam and water in the boiler, pipes and engine. When the admission lasts throughout the stroke, a small proportion of these heat units is consumed in actual work, and a larger volume merely occupy the clearance and cylinder spaces, to be finally swept out and lost in the exhaust. As excessive clearance adds unnecessarily to this volume of wasted heat, it would be especially wise in an engine working under such conditions to avoid it to the utmost extent possible. After the steam supply is cut off from the boiler and expansion begins, the effective pressure is then entirely dependent on the volume admitted, and whether it is contained in the clearance or cylinder spaces, it is all equally valuable in maintaining the expansion line. But the larger the volume admitted, the less the range of expansion, and in this sense only, aside from the question of condensation, can the contents of the clearance spaces be considered loss, which is also true of the entire volume admitted. When steam is worked without expansion, the only difference between the losses sustained by the number of heat units discharged from the cylinder spaces and those discharged from the clearance spaces, is that the former loss cannot be avoided while the latter may be reduced by proper designing. When the steam is worked expansively the heat units stored in both the clearance and cylinder spaces are not used until expansion begins, or, to be more accurate, those that are used are replaced from the boiler; but if the range of expansion be sufficient to equalize the terminal and back pressures, condensation losses only should be charged to clearance. Hence the statement that "the greater the expansion the greater is the loss by clearance" is the exact reverse of the truth.

A greater range of expansion is obtainable in the Cleveland cylinder owing to the absence of condensation and consequent higher effective pressure. It is seldom found necessary to work the lever below the second notch of the quadrant, even on the heaviest grades. The clearances are small and filled by compression to approximate boiler pressure with dry, elastic steam, instead of the inert mixture of water and vapor to which the standard cylinder is accustomed. Initial condensation is thus reduced, possibly, to that resulting from actual initial work. The ideal engine, which has been the dream of inventors for generations, is more nearly approached than ever before by this fleet-footed flyer of the modern steel race track.

Moncton, N. B., Canada. W. F. CLEVELAND.

WESTINGHOUSE GAS ENGINES IN BOSTON.

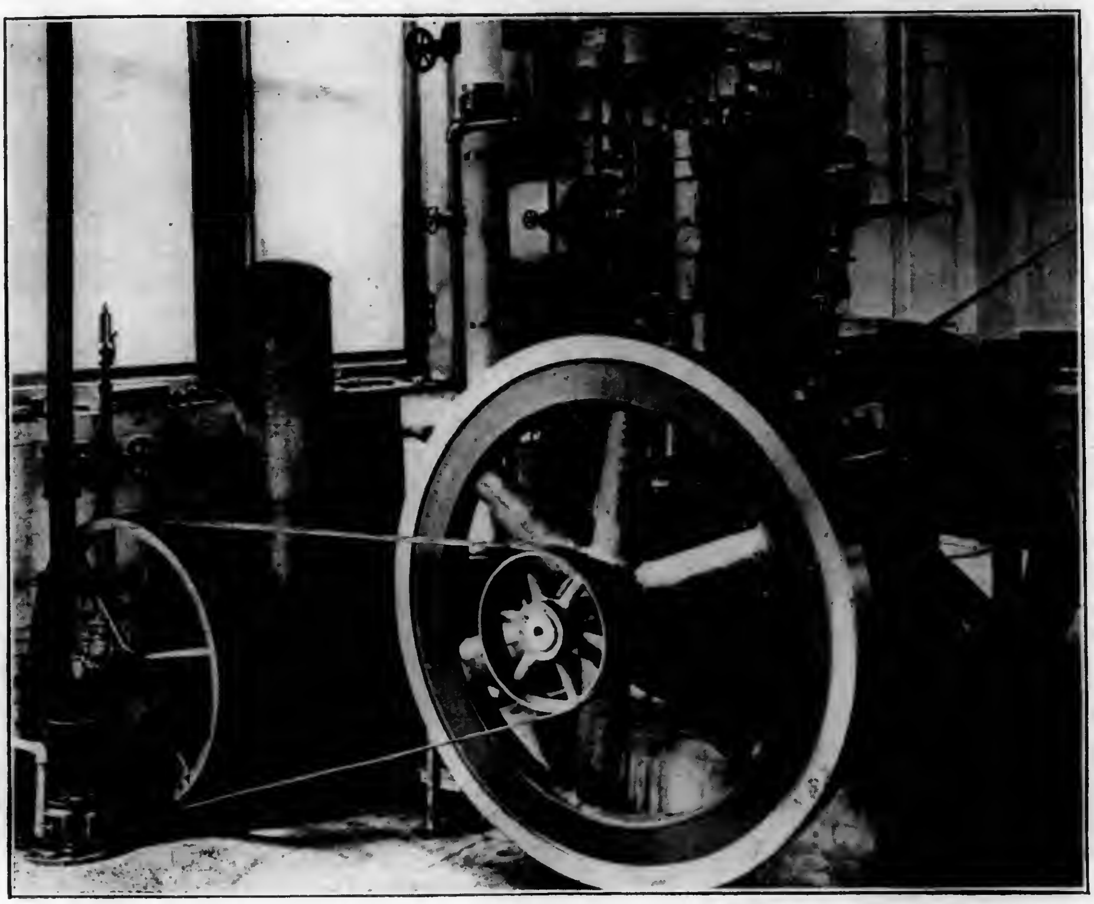
By Burcham Harding.

Some interesting information was secured by the writer when called upon to inspect several Westinghouse gas engines providing power for factories and shops in Boston. The present high cost of coal, and the reduced price of gas in Boston attract the attention of power users to the advantages and economy of gas compared with steam engines. It has long been recognized theoretically that if gas, obtained from coal, could be used directly for driving engines, such a method would be far more economical than if gas was applied to generating steam for operating engines. But only during recent years have gas engines been designed which compete successfully with steam engines in regulation and steadiness of operation.

One of the Westinghouse gas engines visited by the writer, is at the works of the Trimont Manufacturing Company, Roxbury, a large factory devoted principally to producing wrenches, pipe-cutters of a high class and special tools. Power for the works is supplied by a Westinghouse two-cylinder gas engine of 65 horse-power, for which either gas or gasoline may be used as fuel. In the main building a large number of special tools are belted to lines of shafting extending from end to end. In the forging department power is used for operating a number of hammers driven by belts from shafting. The forging hammers, when several are in use simultaneously, place very heavy intermittent strains upon the engine, but the regulation under the varying load is extremely good, changes being noticed only by the greater or less amount of air drawn into the valve for admixture with the charge of gas. With the Westinghouse gas engine the frequency of the impulses is the same for all loads, and the relative proportions of gas and air remain constant, but the amount of the charge admitted to the cylinders, and the consequent strength of the impulse, is graduated exactly for the power required. This system gives a nicety of regulation equaled only by the best types of automatic steam engines. The engine at this factory is run night and day, being stopped only for 20 minutes each day when cleaned and oiled. This steady work has been continued since it was installed in August last. Water for cooling the cylinder jackets is taken from a local well or from the city mains. Part of the discharged water, which has a temperature of 160 degrees, is converted into steam by contact with the exhaust gas, and circulated through the steam radiators for heating the buildings; the remainder is utilized as feed water for the boiler. The fuel gas is supplied by the New England Gas and Coke Company at 60 cents per thousand cu. ft., and contains 650 British thermal units per cu. ft. The average consumption is 17 ft. per horse-power hour, or about 1,100 cu. ft. an hour.

Before the installation of the Westinghouse gas engine, power was supplied by a 55-h.p. steam engine, in conjunction with a 20-h.p. gasoline engine of another make installed in the machine shop. Under the new system not only is there a very great economy in the cost of fuel, but the cost of attendance is reduced, as the engine requires very little attention from the engineer who operates a turret lathe in the engine room.

Another interesting plant is that of H. K. Porter, at Everett, Mass. A 25-h.p. Westinghouse gas engine, which is shown in the illustration accompanying this article, supplies power and heat for this factory upon terms so economical as to be phenomenal. The factory produces bolt clippers in various sizes, from 18 ins. in length, used to clip 5/16-in. bolts, to those 36 ins. in length for clipping ⅝-in. bolts by hand. The 8 by 10 in. gas engine, with two cylinders using gas as fuel, is situated upon the ground floor and is belted to shafting on the same floor and also to the floor above. The gas is secured direct from the gas works which are near by, the bill for fuel being extremely low, not exceeding 50 cents a day. Water for cooling the cylinder jackets is taken from the city mains; part



Westinghouse Gas Engine—Works of H. K. Porter, Everett, Mass.

of the discharge water flowing through a heater 8 ft. high and 15 ins. in diameter, which supplies hot water for heating the building and for pickling the castings and steel forgings. The waste gases from the engine enter the heater at the top, and striking a baffle plate are distributed through the internal pipes and raise the water to a temperature of 180 degrees. The remainder of the discharge water enters the top of a tank 9 ft. high, and is re-drawn from the bottom of the tank for cooling purposes, there being a difference in temperature of 100 degrees between inlet and outlet. The air compressor which supplies the pressure tank for starting the engine is driven by a belt, and the compressed air is also used for sounding the factory whistle and is piped to special tools for removing waste material. At this factory gas is used for power, heat, light and annealing.

The New England Electric Vehicle Transportation Company employ a 25-h.p. Westinghouse gas engine for charging automobile batteries and supplying light, at their establishment near the reservoir at Brookline. The engine is in the basement of the building connected by belt to a 15-kw. Westinghouse compound-wound direct-current generator, supplying current from 110 to 150 volts by means of a regulator which varies the voltage. About thirty 16-c. p. lights are connected with the circuits, the remainder of the current being used for charging the batteries of automobiles. This latter demand is dependent upon the state of the weather so that the engine is sometimes continuously in operation, and at other times stands idle. Gas engines are specially fitted for this intermittent work, as they can be started and stopped with so little trouble, and when not in use no expense is incurred. The air compressor, in addition to being used for starting the engine, is used to pump up the automobile tires, and compressed air is used for cleaning the motors. The gas for fuel costs 13 cents an hour, being charged at 60 cents per thousand cu. ft. The exhaust from the engine is carried by a pipe above the eaves of the roof; a muffler at the top deadening all sound.

LUMEN BEARING METAL.

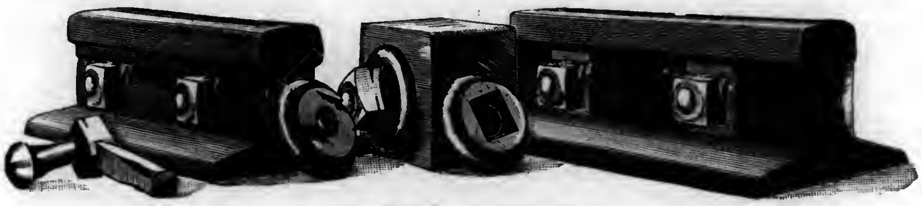
Bearing metals, being one of the subjects before the Master Mechanics' Association, occupied a large share of attention at the recent conventions and interest was shown in the new Lumen bronze manufactured by the Bierbaum & Merrick Metal Company, of Buffalo. This company, besides their regular exhibit, had a pair of main rod bearings which were loaned for exhibition after making 150,000 miles, and after the conventions they were returned to the road from which they came to go into service again. They were in admirable condition, which was a strong endorsement of the claims made for the metal. This bronze was invented by Prof. R. C. Carpenter, of Cornell University, and it was not placed on the market until it had shown successful service for a year and a half in main rod-bearings as a substitute for phosphor bronze. The metal is an alloy which is cast and machined like ordinary brasses and bronzes. Its specific gravity is 6.9, its weight being less than that of brass. Other characteristics determined at Cornell University are as follows: Tensile strength, about 30,000 lbs.; compressive strength, 75,000 lbs.; torsional strength, 35,000 lbs. It is very smooth when cast, and has a shrinkage of 7/64 in. per foot when cast in sand molds. In the solid state its coefficient of expansion is 0.000015 in. per degree F. Bulk for bulk, its weight is from 15 to 25 per cent. less than bronze, the weight of bronze depending, of course, on the composition. There is a distinct advantage in cost because of this lightness. Its compressive strength is sufficient to give good bearing qualities under heavy loads, and it does not appear to cut the journal. In remelting it is stated that there is no deterioration such as occurs in remelting brass and bronze, and lumen metal has the peculiar property of increasing in strength, both tensile and compressive, when heated to 350 deg. F. The metal is a very promising one and worthy of the careful investigation of our readers. We have taken pains to inquire about its service, and have strong indorsements, but have not received any adverse reports or criticisms. The Bierbaum & Merrick Metal Company is represented in Chicago by Mr. G. S. Wood, 95 Washington Street.

THE MORTENSON LOCK NUT.

For Bolts in Wood and Iron.

A nut lock for car work, rail joints, switches, frogs, crossings and in fact all iron structures where nut locks are required, which is less expensive and more reliable than the ordinary double or jamb nut, has for a long time been needed and many devices have been brought forward to meet the requirements. A simple and apparently effective solution has been reached in the Mortenson nut lock, which is illustrated by the accompanying engraving showing its application to track bolts and woodwork. In this device the nut has slits cut at the corners in a plane parallel to and near its bearing face. The washer or angle bar has a depression cut, stamped or rolled into it and the nut, after being screwed home, is secured in place by opening one of these slits and forcing one of the corner lips of the nut into the groove. If stamped, the depression may be made when the holes are punched. The nuts are made of soft steel and the lips are easily bent down without danger of breaking them off. By advancing the nut a short distance on the bolt, the lip is returned to its original position and the nut may be removed in good order for future use. The additional cost of manufacture is merely that of making the cuts, an inexpensive item, when done when the nuts are still hot, in special machines. In car work the grooves in the washers may be cut, stamped or cast, as required, and on fish plates it may be made by the rolls or stamped. The engraving also shows the application of the device to woodwork trestles or bridge work where cast washers are used. In the lower left hand corner the method of turning down one of the lips with a wedge-shaped chisel is shown.

We are informed that this nut lock has been used for 5 years



The Mortenson Lock N t.

by the Southern Pacific in track joints with satisfactory results. This is believed to be a thoroughly reliable nut lock. It has the advantage of preserving both bolt and nut without injury and may be used many times. A glance at this engraving will convince anyone that it will not loosen in service. It appears to be as secure as a split key. If, as in the case of new work, rust or scale for iron, and shrinkage for woodwork, prevent the nut from coming at once to a permanent bearing, with this lock the nut may be tightened up like an ordinary nut and when brought to a bearing again the lock nut is fastened as before. The address of the Mortenson Lock Nut Company is 803 East 170th street, New York.

BULLOCK "TEASER" PATENTS SUSTAINED.

A decree has been entered in the cases of the Bullock Electric Manufacturing Company vs. Baltimore Evening News and Bullock Electric Manufacturing Company vs. Geo. Knapp & Company, publishers of the St. Louis Republic, using the Crocker-Wheeler System, sustaining the validity of the "Teaser" patents, finding an infringement by the defendants and ordering an injunction. The "Teaser" patents cover a system for operating large newspaper presses and other machinery by electricity. The invention is the result of several years of experimenting involving great expense, and this decision gives to the Bullock Company the exclusive right to the manufacture of this apparatus. The "Teaser" System is now installed upon many of the larger daily newspaper presses in this country and England and has proven to be a very successful and economical method for this work.

AIR BRAKE AND SIGNAL COCK FOR CONTROLLING FROM REAR OF TRAINS WHEN BACKING.

Present methods of handling trains between passenger yards and terminal stations require reducing the number of train movements to the minimum and trains are almost universally backed into the terminal station from the yard and backed out to the yard after the run, by the road engine used on the run. This renders it necessary to provide satisfactory methods for controlling the train brakes from the back end and placing in the hands of the brakeman a satisfactory warning signal. The accompanying engraving illustrates a device manufactured by Sherburne & Co., 53 Oliver St., Boston, which is designed to fulfill these requirements. It is a combined plug-cock and alarm whistle (A) attached by a short length of hose or pipe to the "train pipe" of the rear car. The whistle is blown by pressing the button (B) shown in the cut, which allows air to pass through the hollow handle of the cock to the whistle, which is shown on the end of the handle, blowing the whistle and giving the necessary alarm. The manufacturers state that the air used for this purpose, on account of the design of the whistle valve, does not affect the brake system. By moving the handle of the cock in either direction air is exhausted from the train pipe, through the opening C, the brake set, and consequent positive control of the train given. The device is also valuable in switching of freight trains, especially during the night or in thick weather, as the train by its use is under complete control from both ends.

Air Brake and Signal Ccck.

THE "K. A. K." ELECTRIC THIRD-RAIL SYSTEM.

We illustrate this system on page 157 of our issue for May, 1900. The third-rail principle of electric railway construction is the latest development of methods and it presents peculiar advantages for service on elevated and suburban roads, and also for converting steam into electric roads. The third rail is secured to the ends of the ties close to one of the traffic rails. The conducting rail of this system is of iron or steel, made with an ample section, and into the corner of this conductor the trolley fits and bears. The conductor is protected on top and sides in such a way as to avoid difficulties with snow and ice and to render it impossible for passengers or track men to come into contact with the "third rail." It is equally well protected from grease, which would interfere with its operation, by the manner of making the connection on the inner and under surfaces. There is no difficulty in providing for road on track crossings even when they involve a number of tracks. Where the system crosses country roads the conducting rail is cut out for the width of the road and the space is bridged by wires enclosed in pipes. The current is continuous the whole length of the road, and by using two trolleys, one on each end of the car, the crossings are spanned and the cars operated without difficulty. This system is protected by patents and the proprietors are prepared to furnish specifications and estimates and are ready to co-operate with those who are interested in electric transportation. Information may be obtained from Mr. O. S. Kelly, Springfield, Ohio.

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Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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THE M. C. B. AND M. M. CONVENTIONS.

The conventions this year were unusually well attended, and the number of exhibits was larger than ever before. The reports and discussions were disappointing in some respects, but, nevertheless, a large number of very important points were brought out and a number of tendencies toward improvement were plainly indicated. There seemed to be no serious objection to the plan of holding both conventions in a single week, although it cannot be said that the consolidation of the associations is brought any nearer by the concentration of the time of the conventions this year. The comfort and convenience of Saratoga as a meeting-place again impressed everyone, until a great many expressed themselves as hopeful of settling upon Saratoga as a permanent place of meeting. It is understood that citizens of the village have offered to provide permanent quarters for meetings and exhibits, and such a plan would seem to be very advantageous from every point of view. It is particularly attractive to the exhibitors who would profit by the possibility of leaving certain heavy exhibits from year to year, and the convenience of a building especially adapted to exhibition purposes would be appreciated by all. The strongest argument in favor of such a scheme is the possibility of having a hall in which discussions may be heard. Nothing kills the enthusiasm of a public gathering as does the inability to hear the speakers, and with organizations of this character too much attention cannot be given to securing a good hall. This year was not an exception in this respect.

Master Car Builders' Convention.

The fact that the power of locomotives and the weights and capacities of cars have far outgrown present draft gear stood out as the most important technical question in this convention. The tractive power of locomotives, based on 25 per cent. of the adhesive weight, has now reached over 56,000 lbs., and the hauling capacity back of the tender in the recent design of the consolidation type for the Pittsburg, Bessemer & Lake Erie is said to be 7,800 tons, and yet the draft gear capacity is usually less than 19,000 lbs. Something better is needed, and the Association will do well to include in its further work on this problem an examination of friction draft gear, which will absorb 140,000 lbs. Another feature of this question which did not appear prominently in the discussion is the effect of increased spring capacity upon the recoil of draft gear in the trains. It does not seem sufficient to provide more springs unless their reflex action is provided for. The work of this committee will be continued next year and there appears to be plenty to be done.

A great deal was expected from the discussion of center plates and side bearings, and while we should place this second in importance in the technical subjects, no finished result was attained, but next year we may expect some opinions on the question of the design of bolsters, center plates and side bearings, giving information as to the desirability of constructing bolsters to carry their loads free of the side bearings and of the possibility of constructing side bearings making use of rollers in such a way as to carry a proportion of the load continuously upon them. There seems to be a desire to use roller side bearings, and there is reason to believe that they will be able to carry loads continually without flattening the rollers. The advantage sought is the lightening of the bolsters, which would not need to be so stiff and heavy under this arrangement. A question which should be definitely settled is the allowable pressure on center plates. One of the committees recommended 400 lbs. per square inch, and the other recommended double that amount. They cannot both be right. In this side-bearing question the effect of the high center of gravity of large-capacity steel coal cars has not been properly considered. There is reason to fear destructive stresses if such cars are allowed to rock with separated side bearings. This was not mentioned in the discussion, but it appears to add an argument to those in favor of roller bearings continually in contact.

A revision of the specifications regarding the chemical composition of freight axles has been decided upon as the result of an apparently innocent suggestion of a desirable reduction in the proportion of carbon in freight axles because of the rough usage which they receive in interchange business in the matter of cooling the journals in the case of hot boxes. It became apparent at once that such a change required most careful treatment. It involves the most complete understanding of steel, and there is no doubt of the fact that the carbon should vary with the size of the journal. It would be worth while to bring to bear upon this question the knowledge and experience of specialists in steel, and expert opinions by those who are bringing the microscope into their researches will be worth having.

The Interstate Commerce Commission is worrying not a little over the condition of uncoupling attachments to automatic couplers, and a communication from that body to the Association to the effect that many M. C. B. couplers are not automatic because of the poor condition of the unlocking devices ought not to fall unheeded. If these devices are not maintained an M. C.

B. coupler may be made more dangerous than the old form. The force of this criticism was apparently appreciated and one result of the discussion may be to include in the interchange rules the standards of the Association in such a way as to compel the use of proper devices in safe condition in interchange business.

In his opening address as President of the Association, Mr. Schroyer proposed an important change in the basis of representation in the Association. At present no account is taken of the value of cars, but the possession of 1,000 eight-wheel cars gives one vote. The recent advent of the large capacity car makes the old basis somewhat unfair, and it was suggested that the vote should be counted with reference to tonnage. The question is too important for hasty action, but it is likely to be a feature of a future convention.

The Brakeshoe Committee had no tests to report this year, although a number of private tests had been made at Purdue University. An important step which will greatly simplify future work in brakeshoes was the decision to ask the committee to formulate specifications for the frictional qualities of shoes, and other qualities, if possible, with which new brakeshoes may be required to meet before being considered as worthy of trial by railroads. A surprising tendency to use hard shoes with wearing qualities predominating at the expense of frictional effect was developed at this meeting. This is a dangerous tendency in view of the increasing speeds. One of the speakers was surprised to find freight train speeds about sixty-five miles an hour on his own road recently and believed that freight equipment should be constructed with a view of resisting the stresses of such service. In view of this such a dangerous tendency in regard to brakeshoes should be checked.

Among the items of business of this convention one of the most important was the decision to authorize the preparation of an elaborate index of the proceedings from the beginning.

Master Mechanics' Convention.

The whole of this convention was affected in an unpleasant way by the first matter of business brought up, that of the election of honorary members. It seems strange that in an association of this character an hour should be consumed over such a matter and that it should be necessary to expunge the discussion from the record. This points to the desirability of improving the constitution to make a recurrence impossible. Steps have been taken in this direction to be carried out next year.

Some excellent reports were presented this year, among which those of most importance were on electric transmission of power, compound locomotives, piston valves and the ton-mile basis of motive-power statistics. A novelty in the convention was the report of a committee on "What Can the Association Do to Increase Its Usefulness?" This was a species of self examination, and many other technical organizations will do well to follow the example. It would be a good idea to appoint a committee of this kind about once in five years to review the work done and propose improvements of various kinds. We think the most important thought in this report was that of a concentration of effort in the direction of giving the proceedings a high place in technical literature, this being the underlying idea of the committee in all of their recommendations.

Important work was done by the committee appointed to examine present practice with regard to the extent to which the recommendations of the Association have been carried out during the thirty-two years of its existence. From this retrospective view it appears that a very large amount of the work of the Association is not represented in locomotive practice today. Perhaps this was not to be expected, but nevertheless the report is suggestive. As this Association has nothing equivalent to the interchange of cars to compel the use of its standards its work in this direction will probably always be somewhat behind that of the Master Car Builders' Association. It is believed, however, that the method of circularizing the Association failed in this case, as in many others, to bring out the facts as to the practices of the members, and that the recommendations have probably been adopted on a number of roads not represented in the replies. The work of this committee also is needed about once in five years.

It is difficult to say too much in praise of the report by the committee on electric distribution of power. It was a most satisfactory presentation of the reasons for using electrical distribution and contained practical suggestions based upon experience to assist in the selection of the elements to suit various shop conditions. The committee also brought in practice in the form of descriptions of electrical distribution in prominent manufacturing and railroad shops. It is to be hoped that every railroad officer having to do with motive-power matters will give this paper his careful consideration.

The compound locomotive has evidently advanced in the estimation of the members of the Association and it can no longer be said to be in the experimental stage, except in the sense that the locomotive will always be undergoing improvement. There seemed to be a stronger tendency than ever before to regard the compound as advantageous in passenger as well as in freight service, although the greater economy is to be expected in freight service. It appears from the records of the largest builders of locomotives, The Baldwin Locomotive Works, that more than 50 per cent. of the engines built by them last year were compound.

In the discussion of the ton-mile basis of motive-power statistics no criticisms of the principles of ton-mileage figures were offered, attention being given chiefly to matters of detail, such as the question of whether the weight of the engine should be included. The most important facts introduced were the lack of uniformity of units on different roads and the desirability of securing records early in each month. Figures should be so simplified as to permit of getting the returns promptly, especially when the work of men is to be compared, because statistics, which come late, lose their value in the effect on the men, no matter how elaborate and accurate they may be.

There seems no longer to be any question of the correctness of principle of the piston valve. Cast iron wheels were frankly stated by one member to be safer than some steel-tired wheels. There was an almost unanimous expression of opinion in favor of using flanges on all the driving wheels of locomotives. A tendency to consider a lengthening of boiler tubes as advantageous was shown in one of the topical discussions. It was evident that an increase of mileage of locomotives is sought for, whether by pooling or using a number of crews on each engine, but it was made clear that individual responsibility for the condition of the engines is important and that some of the money saved by pooling might profitably be reinvested in the form of better care of the engines.

These comments and the reports to be found elsewhere in this issue present the chief thought brought out in the meetings.

The Westinghouse Air Brake Company has decided to discontinue the use of the oil hole in the standard brake cylinders, because of the trouble arising from carelessness in applying oil through them and the use of the opening as a makeshift substitution for proper cleaning and lubrication.

T. B. Blackstone, for 25 years President of the Chicago & Alton, died at his home in Chicago on May 26. Mr. Blackstone was born at Branford, Conn., March 28, 1829. He began railroad service in 1847 as rodman in the work of surveying the New York & New Haven Railroad. He worked as Division Engineer on the Stockbridge & Pittsfield, on the Vermont Valley and the Illinois Central until 1856, when he was made Chief Engineer of the Joliet & Chicago, in which position he continued until 1861, when he was elected President of the road. When the Chicago & Alton was formed in 1864 he was elected President, from which office he retired April 28, 1899.

PERSONALS.

Mr. J. N. McCarthy has been appointed Purchasing Agent and Chief Clerk to the President of the Florence & Cripple Creek, with office at Denver, Colo.

Mr. John Foster, Superintendent of Motive Power of the Colorado & Southern, has tendered his resignation, to take effect June 15, and it is stated that he will be succeeded by Mr. A. L. Humphrey, Superintendent of Motive Power of the Colorado Midland.

Mr. W. F. Brunner has been appointed Chief Clerk of the Western Passenger Association, with headquarters at Chicago. Mr. Brunner has been City Ticket and Assistant General Passenger Agent of the Vandalia-Pennsylvania at St. Louis for many years.

Mr. Alexander Kearney, Assistant Engineer in the office of General Superintendent of Motive Power F. D. Casanave, at Altoona, has been appointed Master Mechanic of the West Philadelphia shops of the Pennsylvania Railroad, to succeed Mr. R. N. Durborow, resigned to go to the Philadelphia, Wilmington & Baltimore as Superintendent of Motive Power.

Mr. G. S. Wood has been appointed Western Representative of the E. J. Ward Company, Car Furnishings, with offices at Hobbs Building, 95-97 Washington St., Chicago. He has also been appointed representative of the Bierbaum & Merrick Metal Co., manufacturers of Lumen Bronze. Both of these firms are to be congratulated on securing his services.

Mr. L. H. Flanders, who has been an Instructor in the mechanical laboratory of Armour Institute of Technology, Chicago, has accepted a position in the Gas Engine Testing Department of the Westinghouse Machine Company, Pittsburg. The vacant instructorship will be filled before the opening of the school in September.

BOOKS AND PAMPHLETS.

Reinhardt's Technic of Mechanical Drafting, by Charles W. Reinhardt, Chief Draftsman Engineering News. New York: The Engineering News Publishing Co., 1900. Price, $1.

This book is written with the view of helping those draftsmen who are already familiar with mathematics and principles which have to do with the laying out of a mechanical drawing. It is the author's purpose, as stated in the preface, to present to the busy draftsman a thoroughly practical and commonsense guide to good mechanical drafting. The various requirements of a legible drawing such as are met with in practice are well presented, with the exception of the subject of lettering. He, however, refers to a book on free-hand lettering, also written by himself. The errors common to draftsmen, such as inconsistencies in a drawing and the lack of such information as will make them easily read, will be easily guarded against by knowledge of the author's suggestions, which are sure to prove a help to those who will follow them in efforts to produce neat, correct and legible drawings.

Mechanical Engineer's Pocketbook for 1900. Edited by William H. Fowler, Wh. Sc., M. I. Mech. E., M. Iron and Steel Inst. Published by The Scientific Publishing Co., Manchester, England. New York: D. Van Nostrand Co. Bound in leather; pocket size, 4 by 6 in. Price, $1.

This is a good and conveniently-bound book, which has the advantage of annual revision and low price. It contains a large amount of advertising matter (this explains the low price) but it is disposed of in such a way as not to annoy the reader. The impression given the reviewer is that of being up to date, especially in matters of high steam pressure, gas engines, electrical machinery, textile machinery and machine shop tools. The common practice of filling many pages with mathematics and chapters on mechanics has not been followed here, the space being given to tabular matter. We should say that engineers following almost any special practice will find this book very convenient to consult for information on the state of the art in general mechanical engineering practice. The book shows evidence of care in editing, and in the preparation of the matter. It is one which engineers will keep within easy reach of their desks.

Storage Batteries.—The Gould Storage Battery Company of Depew, N. Y., have issued a new catalogue on storage batteries and supplies. These batteries are the result of that which practical experience in central-station lighting and power plants and in all other storage battery lines has shown to be necessary to make the most efficient and durable battery. The catalogue gives complete instructions for setting up, operating and maintaining storage batteries. Information and data, together with this catalogue, will be furnished to parties considering the use of storage batteries for any purpose, by addressing the New York office, Astor Court Building, 25 West 33d Street.

Pneumatic Tools.—The Chicago Pneumatic Tool Company have just sent us a new catalogue which they have issued for distribution at the Paris Exposition. The description of each tool or machine is concise and is printed in English, French and German. The catalogue also illustrates tools for all branches of industry which are in use in a number of important shipyards, railroad shops and manufacturing plants. The engravings represent these tools in practical operation. The presswork represents a very high degree of perfection and brings out with remarkable clearness the most minute details in every instance, and as a whole this is a very attractive and beautifully illustrated catalogue.

The Harrison Dust Guard.—A small folder has been issued by the Harrison Dust Guard Company, Spitzer Building, Toledo, O., giving the number of guards ordered and furnished to the American Car and Foundry Company, Barney & Smith Car Company, Pullman Car Company, Pressed Steel Car Company, Illinois Car & Equipment Company, Richmond Locomotive Works, Brooks Locomotive Works and International Power Company, during the month of May, 1900, which was a total of 33,712. This number does not include the orders from the railroad companies.

In the Adirondack Mountains.—People who are familiar with the "Four Track Series" issued by the passenger department of the New York Central, as well as those who do not know what a great aid this series is to people seeking pleasure and recreation in the territory tributary to this road, will be glad to learn that Nos. 6 and 20 of the "Four Track Series," entitled "In the Adirondack Mountains," has just been issued. The former is a booklet of 72 pages containing many illustrations of such beautiful mountain scenery as to immediately set up a yearning for the woods and the smell of the camp-fire. Illustrations of the principal hotels are given, together with a brief description of the places and large maps; also a complete list of the hotels and boarding houses with their location and rates. Number 20 is a 48-page folder containing large maps of the region and valuable information which cannot be found in any other publications. The book or folder will be sent free, postpaid, to any address, on receipt of a postage stamp, by George H. Daniels, General Passenger Agent, Grand Central Station, New York.

The Hayden & Derby Mfg. Co., 85 Liberty St., New York, with factories located at Bridgeport, Conn., have just issued a new catalogue, standard size, 9 x 12, of 28 pages, illustrating the "Metropolitan 1898 Locomotive Injectors," for locomotive service. The catalogue is very complete, showing the various types which they manufacture, also plates showing the specifications as to sizes of pipe connections, and details as to repair parts. This catalogue also illustrates in detail the H-D locomotive strainer, the H-D combined stop and check valve, the H-D swing, intermediate and line check valves, main steam valves and main boiler check valves, all as applied to locomotives. Many of the other products for ejectors and injectors for stationary boilers and locomotives are illustrated in detail. In addition to the usual price list showing pipe connections, this new catalogue shows the detail tables of capacities with various temperatures of feed water, the range of capacity with various steam pressures and various temperatures of feed

water, which is especially interesting to railroads and railroad men now that the subject of heating the feed water is being so generally discussed and advocated. The Hayden & Derby Mfg. Co. will be pleased to mail this catalogue to anybody upon application.

A small folder has just been received from the Joseph Dixon Crucible Co., miners, importers and manufacturers of all forms of Graphite, showing engravings of the American Exchange National Bank Building and the Broadway-Chambers Office Building, both in the course of erection in New York City. The steel work of these buildings is protected with silica-graphite paint, manufactured by this company. The folder also gives paint specifications calling for the use of Dixon's silica-graphite paint for the protection of structural steel and tin roofs.

Machine Tools.— The Pond Machine Tool Company of Plainfield, N. J., have issued a unique and very handsome catalogue for distribution at the Paris Exposition. This little book of 95 pages is 5 by 9 in. in size and bound in heavy boards. The products of this company are confined to a line of machine tools, including engine lathes, planers, radial drills, boring and turning mills and railroad shop machinery for wheels and axles. These tools, which are of the most modern design, heavy and powerful, are the subjects of this book. Each class of machine is given a general description in English, French and German and illustrated by excellent engravings. The book is well printed, making it very attractive.

The Russell Snow Plow Co., 751 Tremont Building, Boston, have issued their catalogue for 1900, from which it appears that during the past two seasons the demand for their plows has been greater than the capacity of the works to supply. This being the time for considering such equipment for next winter, the early placing of orders is urged. Our readers are familiar with the features of these plows, but to be informed of the latest applications of the experience of these builders copies of the pamphlet should be obtained. The illustrations are excellent and the catalogue closes with a strong guarantee of the plows by the manufacturers, whose wide experience should be considered when ordering new equipment of this kind.

Oue of the handsomest souvenir catalogues distributed this year at the Master Mechanics' and Master Car Builders' Conventions was that of the Bullock Electric Manufacturing Company, Cincinnati, O. The pamphlet illustrates characteristic designs of their dynamos and motors, also several applications of the Bullock motors, specially designed for direct connection. This unique and interesting book is believed to be the work of Mr. F. G. Bolles, manager, Advance Department of the Bullock Electric Manufacturing Company.

The J. G. Brill Company have issued a pamphlet illustrating and describing their "No 27 Perfect Passenger Truck." This truck, which was designed for electric and steam railway service, was fully described in the March and July, 1898, issues of this paper. The Brill truck, which is well known to our readers, has shown the only important improvements in design for passenger trucks during a number of years. That the construction has attracted the attention of motive power officers was plainly evident at the April meeting of the New York Railroad Club, when the subject of Standard Trucks for Railroads was discussed. Copies of this attractive little pamphlet may be had by addressing the J. G. Brill Co., Philadelphia, Pa.

Hydraulic Pumps.—The Watson-Stillman Company, of New York, have issued a new catalogue, No. 56, which is one of a series of subdivided catalogues covering their machinery for a great variety of purposes. This book brings together in very convenient form an assortment of illustrated sheets of hydraulic pumps, among which are testing pumps, horizontal double-plunger hydraulic pumps, side cistern single and double-plunger hand pumps, 1, 2, 3, 4 and 6 plunger belt pumps, 2 and 3 plunger vertical belt pumps, 4 and 6 plunger geared belt pumps, 6 plunger differential piston belt pumps, 2 and 4 plunger engine-driven pumps, single steam cylinder pumps and duplex steam hydraulic pumps. Besides the standard styles which are shown in this catalogue, the company is prepared to furnish many other styles and sizes. Some very desirable features in the design of these pumps are the placing of all valves above the cistern top, where they may be readily examined, provision for easily taking up lost motion and the interchangeability of the smaller parts. The engravings in the catalogue are clear and the descriptions concise.

"Two to Fifteen Days' Pleasure Tours."—The passenger department New York Central & Hudson River Railroad have just issued one of their "Four-Track Series," No. 8, entitled "Two to Fifteen Days' Pleasure Tours." This book contains many illustrations of delightful summer resorts and some valuable information as to how to reach them by the New York Central. It also gives a very compact table of the time and rates of fare to one hundred and thirty popular resorts. This pamphlet will be a great help as a reference book to those who are contemplating a summer trip and will be sent free to any address on receipt of a postage stamp at the office of George H. Daniels, General Passenger Agent, New York Central & Hudson River Railroad, Grand Central Station, New York.

The Standard Pneumatic Tool Company of Chicago have just issued a "Paris Special Edition" circular No. 9, which represents in concise form a number of the "Little Giant" pneumatic tools and appliances which have just been placed on the market, among which are hammers for chipping iron and steel castings, single and double spindle boring machines, which are reversible at full speed, breast drills, screw feed drills and casting cleaners. These machines are simple in construction and are made expressly for hard service. Interesting installations of the machines are also shown in the circular.

Baldwin Locomotive Works.—A very handsome pamphlet has been sent by the Baldwin Locomotive Works, giving a general description, together with half-tone and line engravings of the express passenger locomotive built by the Baldwin Works for the French State Railways and the freight locomotive built for the Great Northern Railway of England, which are exhibited at the Paris Exposition. The catalogue also contains a report of the organization of the works and the steady yearly increase in the output. It is interesting to note that, while thirty years were required in building the first one thousand locomotives, almost the same number were built in the single year of 1890. Considerable space is given to illustrating steel-tired wheels which are manufactured by the Standard Steel Works. The engravings, with the exception of those of the wheels and tires, are excellent. These would be improved by clearer dimension figures. The press-work is of a high order of merit, which, added to the other good features, make it an unusually fine production.

Special Railroad Machine Tools and Appliances.—The Pedrick & Ayer Co. have just issued a new catalogue of 126 pages, illustrating special railroad machine tools and appliances of which they have been noted makers for many years. Some new tools are shown in connection with their compound locomotive cylinder boring bars and special Corliss valve-seat boring bars, and there is a radical departure from former catalogues in the way of a very complete line of pneumatic hoists, vertical and horizontal, with necessary appliances, as well as jib and traveling cranes, which are illustrated, together with some interesting installations of these hoists. Special attention is given to improved pneumatic riveting machines for light and heavy work, which this company has only recently put on the market. The catalogue also shows a change in the ratings of the company's machines, which gives the total effective pressure exerted on a rivet, with various sizes of standard frames, ranging from 43,000 lbs. to 188,000 lbs. exerted pressure on the rivet, also the length of the final effective stroke which carries this maximum pressure. Whether the rivet be 2½ ins. or 8 ins. in length, the construction of the machine takes up the difference instantly, without any adjustment, and then admits of so much effective stroke. In arriving at the effective pressure desirable for a given size rivet, the Pedrick & Ayer Co. state that it is the practice of the best concerns to make a distinction of 20 per cent. less pressure on rivets for structural work than for steam-tight work. Copies of this catalogue will be furnished upon application at the offices of the company, 85, 87, 89 Liberty Street, New York.

Bullock Type "I" Generator.—The Bullock Manufacturing Company, Cincinnati, O., have issued a pamphlet, Bulletin

No. 34A, illustrating and describing in detail their type "I" generator, which was designed for direct-connection, to steam or gas engines. It does not differ materially in general design from their standard belted machines, but is more compact, the general appearance neat and the outline very pleasing.

Electric Sprinkling Cars.—The J. G. Brill Company of Philadelphia have issued a circular No. 55, illustrating and describing the Brill sprinkling cars for electric street railways. These cars are built with tanks of 1,800, 2,500 and 5,000 gals. capacity. Their standard car has a tank of 2,500 gals. capacity. The sprinklers themselves have a special form of patent sprinkling head, which is very easy of operation, making it possible for one man to run one of these cars. Such sprinklers not only add to the comfort of the passengers, but keep grit and wearing substances from entering the bearings of the machinery, and they contribute to the economy of electric current, by reason of better contact between the wheels and rails.

"Early Tramroads and Railways in Leicestershire" is the title of a very interesting pamphlet, by Mr. Clement E. Stretton, Consulting Engineer, Saxe-Coburg House, Leicester, England. This rather concise history of the railways in Leicestershire, dating back as early as 1789, first appeared in the "Burton Chronicle" and is now put in pamphlet form for distribution. Mr. Stretton is well known as a locomotive historian and the world is indebted to him for many contributions to locomotive history.

EQUIPMENT AND MANUFACTURING NOTES.

The Modoc Soap Co., Cincinnati, Ohio, have distributed handsome packages of playing cards contained in an attractive pocket case. On an additional card eight reasons are given why "Modoc Liquid Car Cleaner" should be adopted by railroads. This cleaner is advocated because it feeds and polishes varnish, it is a linseed oil preparation and does not contain benzine to injure varnish and cause rapid deterioration by evaporation. The fact that it is used on many of the best railroads and the superior appearance and greater durability of the paint and varnish are urged in strong claims.

Mr. W. D. Sargent, general manager of the Sargent Company, Chicago, returned from Europe Saturday, June 23, after a two-months' trip.

The Richmond Locomotive and Machine Works are shipping to the Paris Exposition, on the French Line steamer "Bordeaux," one 16-in. x 24-in. 10-wheel locomotive, built for the Finland State Railways. Their order was for ten engines, nine of which have already been shipped to Helsingfors.

Mr. J. W. Duntley, President of the Chicago Pneumatic Tool Company and also President of the New York Air Compressor Company, who has recently returned from Europe, brought with him an order for twelve air compressors for European shipment. The New York Air Compressor Company has also received an order for one of their compressors to be shipped to Yokohama, Japan.

The Ajax Metal Co. report greater activity than they ever experienced before and they are behind with orders in spite of running double night forces. One of their most popular products is "Ajax Plastic Bronze," which is attracting attention on prominent railroads. This company has for years combined a scientific study of bearing metals and the composition of alloys with their manufacture and to this fact a large part of their great success is due.

A branch office of the Magnolia Metal Company has been opened in San Francisco under the management and control of Messrs. Charles C. Moore & Company, Engineers. This firm has branch houses in Los Angeles, Seattle and Honolulu and by a recent contract the Magnolia Metal Company gives them the sole and exclusive agency for Magnolia Metal in the States of California, Oregon, Washington, Montana, Nevada, Idaho, Arizona, Utah and New Mexico; also in the Hawaiian Islands. The firm is well known throughout this territory and the connection will undoubtedly be a very valuable one.

Mr. J. W. Duntley, President of the Chicago Pneumatic Tool Co., before his recent return to this country, cabled from Europe as follows: "I have to report fresh orders for 1,000 tools." This is a remarkable order which reflects the condition of the demand for pneumatic tools abroad. The progress of this country in their adoption was very unusual, but in Europe it is phenomenal.

The Sargent Co., 675 Old Colony Building, Chicago, have issued a pamphlet entitled Cast Steel Wheel Centers, in which a number of designs of driving wheels, made by them, are illustrated from working drawings. These are interesting, because they show the driving-wheel practice of a number of roads and they also illustrate the designs which these manufacturers approve. The Sargent Co. recommends making the rims solid and splitting them. They also recommend patterns in which cores for hubs and counterbalance pockets are omitted. Correspondence on the subject of cast steel wheel centers is invited. The pamphlet is valuable as a record of practice, and gives the weight and dimensions of 17 wheel designs.

The Foos Gas Engine Company, Springfield, O., a short time ago received a letter from Messrs. Bollinger Brothers, Engineers and Contractors, of Pittsburg, from which the following is quoted: "After some very unsatisfactory experience with two gas engines, wrestling with them for several months, we were compelled to throw them out, placing in one of your 8-h. p. gas engines, which has been at work now for some eight months, and always doing its work in a very satisfactory manner. We are much pleased with the performance of this engine, believing there is no better engine made." This is a satisfactory and pleasing endorsement of the Foos gas engine. The builders have had thirteen years' experience in the construction of gas engines.

It is believed that the admirable properties of mineral wool for railroad use, while appreciated by many, are not as well known as the qualities of the material deserve. It is a clean, inexpensive, non-combustible heat, cold and sound insulator and is specially well adapted for use as a filling for passenger car sides, ends and floors. It is equally valuable as an insulator for refrigerator cars, where its permanent and practicably indestructible qualities are especially appreciated. It does not decay or solidify, when properly packed, and its relatively light weight is also favorable. Mineral wool is also used very successfully as a covering for exposed water tanks, for steam boilers and steam pipes. Information may be obtained from the United States Mineral Wool Co., 143 Liberty Street, New York.

The Clayton Air Compressor Works, 26 Cortland Street, New York, have recently perfected a new type of Duplex Belt Air Compressor. These machines are built in small and intermediate sizes and embody all of the latest improvements. Although their facilities have been doubled, it has only been by most diligent and careful management that they have been able to make reasonable deliveries. They have recently equipped five plants of the Brooklyn Heights Railroad Company with compressors and pneumatic hoists; also the Grasselli Chemical Company, General Chemical Company, De La Vergne Ice Refrigerating Machine Company, Union Brewing Company, Gill Machine Works, White Machine Shops, etc. Their export trade has more than doubled and they are shipping their product to England, Germany, Russia, France, Italy and Japan. Many orders are being received from Mexico and South America. Information concerning their product will be furnished by this company upon application.

An apparently successful combination of the Janney coupler with the hook coupler, commonly used in England, is now being tried experimentally on the Great Northern Railway, England. As illustrated in "The Engineer," the drawbar terminates at its outer end in a hook for the ordinary English chain coupling. Over this hook a Janney "M. C. B." type of coupler is hinged in such a way as to be raised and held in place by a pair of pins when wanted. When the hook and chain are wanted the coupler head is dropped out of the way and the hook exposed for use. The arrangement seems to be giving satisfaction.

MASTER CAR BUILDERS' ASSOCIATION.

Thirty-fourth Annual Convention.

Abstracts of Reports.

SIDE BEARINGS.

Committee—J. W. Luttrell, B. Haskell, H. M. Pflieger.

Standard Spread.

In the replies received to a large number of inquiries issued, in securing information and data of results obtained from the general and customary practice in the use of side bearings, the importance of a standard spread seemed to be regarded secondary to the necessity for clearance. Although this is a feature of much importance, it was found that the distance from center to center of the bearings, as practiced by a large number of companies, did not vary sufficiently to occasion controversy or affect the results in service; the difference being from 53 to 62 in.

It is believed that the most satisfactory location is just within the arch bars, or about 60 in. from center to center of the side bearings. A large number of companies at present specify this dimension, and inasmuch as the total variation in nearly all cases is small, there would probably be no difficulty in establishing it as the standard. The approximate uniformity in this measurement is taken as an evidence that it is recognized as the best practice, and your committee recommends that 60 in. be adopted as the standard.

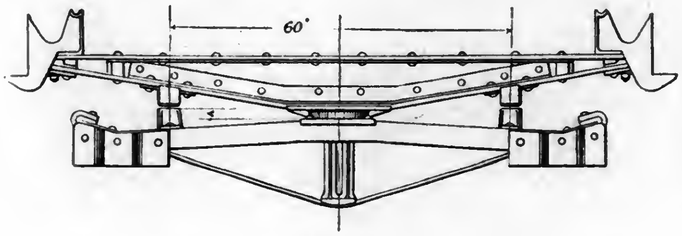


FIG. 1.

In agreeing upon a standard spread your committee would also emphasize and advocate the adoption of a standard height from top of bottom side bearings to the bearing surface of the bottom center plate. While not affecting the design of the bearing itself, it will permit the interchangeability of trucks where the standards have been observed.

By reference to Fig. 1, which shows a body and truck bolster of metal structure, the standard spread as recommended will be found expressed, the letter "A" indicating the height from bearing surface of bottom center plate to the top of bottom side bearings.

Side Bearing Clearance.

In view of the discussion which has arisen at different times in the past, relating to side bearing clearance and the advisability of carrying the weight of car body and load on the center plates entirely, or equally distributed on the side bearings and center plates, it was somewhat of a surprise to find expressed in the replies to your committee's circulars of inquiry, a unanimous opinion in favor of carrying the load on the center plates, and, with one exception, a clearance between the side bearings advocated. As these recommendations represent the results of long experience, observation and tests, it would seem unnecessary to go into lengthy detail as to the relative merits of the two conditions. However, to add more information, if possible, and confirm the prevailing opinion, your committee conducted a series of tests with a view of determining the relative resistance under the different conditions.

A box car of late design, with a capacity of thirty tons, was used. The body bolsters were of the double leaf iron type, with a 10 by ¾-inch top plate and 10 by ⅞-inch for the bottom plate; the regulation cast-iron thimbles being interposed between the members at the sill bolts, and with a cast-iron filling block at the center. The car had rigid trucks, with Simplex truck bolsters, and a 15-in. channel-iron spring beam. The weight of the empty car was as follows:

	Pounds.
Body	18,700
Trucks	11,400
Total weight	30,100

The car was loaded with one hundred car wheels, weighing 60,800 lbs.; the weight on each truck being equalized by placing fifty at each end of the car. Adding the weight of the car body will give a total weight of 79,500 lbs. on both center plates. The total area of contact surface of center plates was 56.56 sq. in., which, with the weight stated, is equivalent to 1,405 lbs. per square inch on the bottom center plates, with the car body clear of the side bearings.

An inclined track with a grade of 4 ft. in 100 ft., having a 15-degree curve at its base and leading to a straight track, was selected to make the tests. In all cases the loaded car was placed on the incline, with the center line of the front pair of wheels at a point 125 ft. from beginning of the curve, as shown in Figs. 2 and 3, where it was held with the hand brakes.

Test with Clearance Between Side Bearings.

In the first test the car was adjusted empty to give a clearance of ⅜ inch between the side bearings. After the car was loaded there was no appreciable deflection. Thus the entire weight of car body and load, or 79,500, was imposed on the center plates, that is, 39,750 at each end. The car was placed on the incline at the point stated; the brakes were released as quickly as possible, whereupon it started and moved rapidly until the curve was reached, where the speed slackened; after reaching the straight track the car resumed its normal position with respect to the side bearings, and traveled 345 ft. before coming to a stop. The rounding of the curve seemed to be attended with but little friction, and in riding on the car there was no perceptible shock or straining.

Test with Weight Carried on Side Bearings and Center Plates.

The height of the side bearings was then adjusted to distribute the weight on the center plates and side bearings as equally as possible. The contact area of the side bearings was 15 sq. in. each or 60 sq. in. for the four; adding the area of the center plates gives a total of 116.56 sq. in. carrying the car body and load, which is 682 lbs. for each square inch. In each instance the car rode very hard, and the sudden slackening of speed when the curve was reached produced considerable shock and straining to both body and trucks.

Test with Roller Side Bearings.

The car was then equipped with anti-friction side bearings having two chilled iron rollers to each bearing, connected with top and bottom seats with chilled surfaces for the movement of the rollers. The adjustment was such as to produce equal weight on center plates and side bearings. The freedom of movement seemed to be about the same as in the first test with a clearance between the side bearings. The car was then raised off the side bearings ⅛ inch. This did not result as satisfactorily, as indicated by the distances traveled.

There was no difference noticed in the conditions, when the car rounded the curve, compared with the preceding test.

For the convenience of comparison, a table is given herewith summarizing the results of each test, expressed in feet traveled on the straight track after the car had traversed the curve:

	Side Bearing Clearance.	Weight on Side Bearings.	Anti-friction Weight on Bearings.	Anti-friction ⅛ inch free.
	Feet.	Feet.	Feet.	Feet.
First trial	345	203	325	284
Second trial	...	197	335	346
Third trial	...	176	372	303
Fourth trial	...	212	350	...
Average	345	197	345½	311

The results of the tests would indicate that the most satisfactory condition for service would be to have the weight carried on the center plates, and with a clearance between the side bearings. While the anti-friction bearings under certain conditions produce an average slightly better, the difference is insignificant. Furthermore, it would appear that a correct adjustment is necessary, otherwise the results would not be as satisfactory.

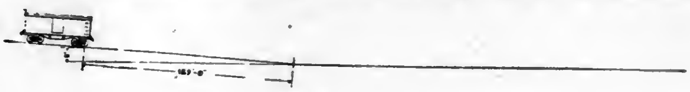


FIG. 2.

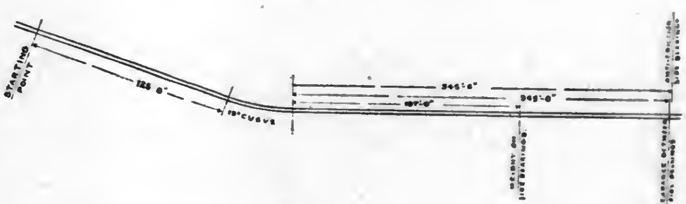


FIG. 3.

The fundamental requirement in maintaining this clearance is a construction of truck and body bolsters which will insure a minimum amount of deflection. Your committee is of the opinion this can not be obtained with wooden bolsters, as the possibilities of deflection in their use demands a greater clearance at the outset, and which, unless given frequent attention, gradually disappears. It is believed the best results can only be obtained from a good form of metal bolster.

The extent of contact surface of center plates is also considered an important factor as influencing the proper movement of trucks in traversing curves and in relation to the side bearings. It is well understood that safe practice opposes excessive weight for each square inch of bearing surface; and that better results will be derived from center plates with large area than if too small. The ones used under the car in making the tests had a bearing area of 28.28 sq. in. each, producing 1,405 lbs. per square inch with a car body and load of the weight stated.

Your committee considers this plate too small, and is of the opinion that the size should be such as will impose about 800 lbs. per square inch of contact surface.

As to anti-friction side bearings, your committee has not been able to satisfy itself that this type of bearing has attained a sufficient degree of perfection, as far as can be learned, to insure superior results compared with the present practice, considering the increased cost, especially in freight-car construction. Theoretically, a device which will facilitate the movement of the truck when traversing a curve would be of advantage; but from the information obtained, it is demonstrated that the rollers, which enter into the construction of nearly all anti-friction side bearings, soon become flattened and then the bearings are of no more value than the older design, if as good.

In concluding its report, your committee desires to state that after careful investigation and inquiry among a large number of companies, it is convinced that the best results can only be obtained from a proper clearance between the side bearings. In fact it developed that an important line was refusing cars unless there was such clearance, doubtless an evidence that it is considered a question of safety under some conditions.

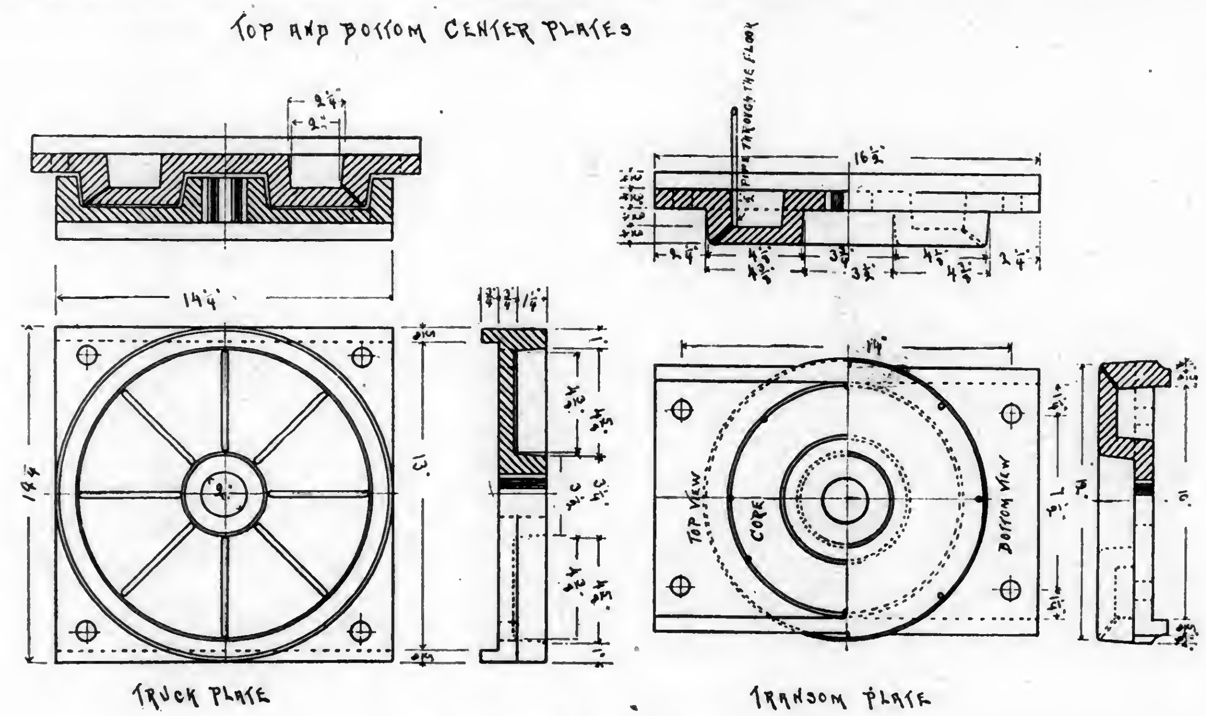


FIG. X.—Center Plate for 60,000-pound Car.

STANDARD CENTER PLATES.

Committee—R. H. Johnson, G. T. Anderson, H. L. Preston.

From the data presented by the replies from members (Not reproduced in this abstract.—Editor), the Association can see how varied are the opinions of those constructing or maintaining cars. Your committee feels bound to call attention to those answers wherein the blame or failure of pressed steel or malleable iron castings are attributed to light construction.

Another feature we would mention is shown by steel and malleable center plates crushing under load and becoming so fixed that they will not permit the car trucks to curve. This, we believe, is brought about by the excessive length of pressed steel, malleable or cast iron center plates. It is an established fact that wooden bolsters, or wood and iron combination bolsters, will spring, and it necessarily follows that the long center plate must spring with the bolster. If of light construction, this curvature will necessarily force the outer edges of the center plate inward. This action will nip the bottom section fast, causing a rupture, either by separation of the lower or bearing part of the center plate, or where it curves to form the circle. This would explain the many answers claiming that breakage was due to load, and bottom or top section crushing out. Your committee, therefore, would advise shortening the bearing of center plate as much as possible, thus reducing the bearing surface lengthwise of the bolster.

The next question pertains to the dimensions given for bearings. There should be some relative dimension governed by load for center-plate construction, and without going into a scientific analysis will call your attention to a few conditions that may be readily followed and give reasonably good results.

First. Those loading cars should have impressed upon their minds the importance of loading the cars as evenly as possible, so that the cars will be, as the ship loader would call it, "trim." Assuming that the car is loaded evenly and that the average width is about eight feet, taking the load on one center plate to be about 40,000 lbs. will give for each foot of width of car about 5,000 lbs. Assuming further, that 400 lbs. to the square inch of surface should be the general rule for center-plate service, there will be required a center plate about 12 in. in diameter, less the space of 2 in. for king bolt and 1¼ in. for inside ring, which would give about 100 sq. in. for bearing surface. The surface of this center plate being flat, by the aid of an emery wheel it could readily be smoothed off. This would give, comparatively, a smooth surface upon which the 40,000 lbs. would rest. Now, let us say that some outside force had caused the car to list; for instance, entering a curve. While upon the curve, the natural tendency would be to throw all the weight upon the outer edge of the 12-in. center plate, and the result is that the center of load bearing has moved over 6 in., resulting in five-eighths of the weight being on one side of the bearing point, equaling about 25,000 lbs. The natural tendency would then be for the car to re-establish its normal or vertical position at the earliest possible moment by overbalancing the remaining three-eighths of the weight on center plate.

From such a center plate there would be no question but that it would carry the weight of the car and maintain, under reasonable conditions, the vertical position required, thus relieving the side bearings of all duty excepting that of a safety appliance to catch the car in time to prevent damage from any sudden shock in a lateral direction.

The second condition is that of the center plate shape. It is understood that our metal bolster-making friends claim a large saving to train friction by the use of their bolsters from the fact that the metal bolster will maintain its general contour under any load, thus assuring, under general conditions, that the car will not ride on its side bearings. Such being the case, on what principle of adjustment do our builders construct a ball or dished-shaped center plate? It is evident that a ball surface or sphere offers the least resistance to a rolling motion, and there is no constructor who would believe that a car, mounted on two 20-in. balls, would maintain its position going around a curve at a rate of 20 miles per hour for as many minutes. That they fear displacement is shown by the construction of a ring at the bottom of the circle that limits, if it does not prevent, the rolling motion that they expected to receive when the ball or center plate was evolved.

As long as the inner ring remains in position, reinforced by the king pin, the car retains its position upon the truck, but should sufficient force be exerted to cause the breaking of this ring, the same force will break the king bolt and cause displacement of the center plates.

Another feature in this construction that is very much in evidence is the listing of the cars to one side bearing, then to the other. With a ball-bearing center plate, if the car should list, what is there to cause the car to assume a vertical position? Must it not remain upon the side bearing until the trucks find some high place on the rail to enable it to toss the car over to the opposite side bearing? If this action is a fact, then is it not also a fact that the car must be literally tossed from one side bearing to the other or remain permanently upon one side bearing, increasing flange wear?

As there is nothing to prevent the rolling motion to this ball-bearing center except a tight fit around the center ring or king bolt, therefore what advantage can be claimed in a construction that necessitates a condition to prevent the natural result one must expect from a curve construction, which thus nullifies

the advantages that the metal bolster makers claim in their construction of rigid bolsters.

We attach, for inspection, various blue prints sent us by those answering our questions, and have here a wooden model showing a center plate with oiling device. Also, would call your attention to figure marked "X" that will show the general dimensions of a plate for 60,000 lbs. capacity car, having about 100 sq. in. of surface to carry about 400 lbs. per square inch; also grooves in male face to assist the rapid distribution of the oil over the face of the male center plate. The oil reaches the recesses on the top of said plate from within the car through a ½-in. pipe, and the six holes through the plate at the edge of same allow the oil to escape into the grooves and over the lower center plate surface.

AIR-BRAKE APPLIANCES AND SPECIFICATIONS FOR AIR-BRAKE HOSE.

Committee—A. L. Humphrey, A. M. Waitt, W. H. Marshall.

Your Committee on Air-Brake Appliances and Specifications for Air-Brake Hose sent out a circular of inquiry regarding any suggested additional standards for air-brake appliances, slack adjusters, additional air-brake power upon heavy-capacity cars and in connection with specifications for air-brake hose. Only eight replies were received to the circular from representatives of railroads, showing apparently that very little vital interest is taken in this subject at the present time.

It seems to your committee that those in charge of motive power and car departments on railroads should see that employes who have to do with the repairs, maintenance and adjustment of air brakes on cars give more attention to the importance of a correct piston travel in order to have the brakes operate as nearly as possible at their point of maximum efficiency.

Your committee would call attention to the great neglect regarding the proper care of air-brake cylinders on freight cars. Many seem to think it simply necessary to remove the oil plug in the cylinders and put in a quantity of inferior-grade oil, leaving the packing leathers oftentimes hard and badly cut or worn. Experience seems to show that a light grease is more advantageous to use than a heavy oil, and it has also been found desirable to have the cylinders made without any oil hole, thereby making it necessary, whenever the cylinder is to be oiled, to take off the cylinder head, and so that at the same time the lubricating is done the packing leather and rings and the inside of the cylinder will receive proper attention in the way of cleaning, and any other necessary repairs required.

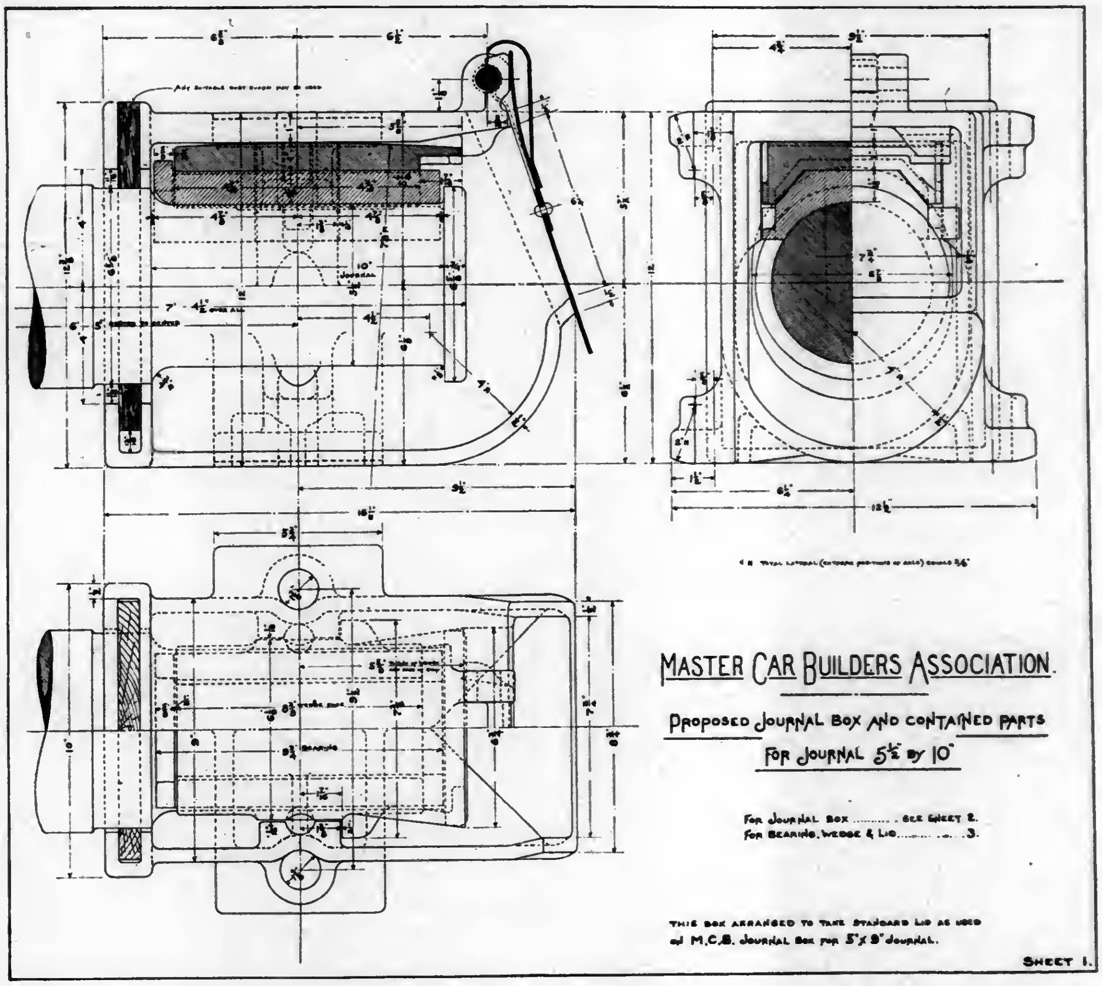
Your committee believes more attention should be given to reducing the number of elbows that are found in the piping of many cars. Every sharp bend in the pipe means a retarding of the action of the brake and added friction in the movement of the air through the pipes. As far as possible, in designing air-brake piping for cars, "ells" should be eliminated and long, easy bends substituted.

It has been suggested by one of the air-brake companies that on Plate 9 of the Association Standards for Air Brakes on Freight Cars, the dimension showing the location of angle cocks should be given, as well as the angle at which this cock should stand with reference to the vertical. Your committee would recommend that this feature be referred to the Committee on Supervision of Standards, for them to consider and make definite recommendations at our next convention in 1901.

Your committee does not believe that it would be advisable to continue a general Committee on Air-Brake Appliances and Specifications for Air-Brake Hose at the present time, but there would seem to be an opportunity for a special committee to take up the subject of The Use of Slack Adjusters and the Consideration of the Necessity of Additional Brake Power on High-Capacity Cars, together with the subject of Specifications for Brake Beams for High-Capacity Cars.

It has also been recommended by some that further consideration be given to the subject of Air-Brake Hose Specifications by a committee who will take up this subject exclusively.

These suggestions and the information given above are respectfully submitted.



JOURNAL BOX, BEARING AND WEDGE FOR CARS OF 100,000 POUNDS CAPACITY;

Also

JOURNAL BEARING AND WEDGE GAUGE FOR CARS OF 80,000 AND 100,000 POUNDS CAPACITY.

Committee—Wm. Garstang, J. J. Hennessey, W. H. Marshall.

Your committee, instructed to prepare plans for a journal box, brass and wedge for 5½ by 10 in. axles for cars of 100,000 lbs. capacity, and limit gauges for journal bearings and wedges for cars of 80,000 and 100,000 lbs. capacity, submits drawings for these parts for your consideration:

In preparing these plants it has been the aim to design the parts, as far as possible, with a view of using present standards without detriment to the design. This has been found practicable with regard to the journal-box lid only. The present standard lid for 5 by 9 in. boxes is of sufficient size to cover

the necessary opening in the proposed 5½ by 10 in. box, by reducing the overlap on each side.

The design of the brass is made with a view of reducing the non-wearing parts to their minimum weight and size consistent with the required strength, and to increase the bearing and wearing surface as much as possible.

The size of the box is kept as small as possible to decrease weight and increase its strength, with special reference to making the box of sufficient capacity for oil and waste, and at the same time limiting that capacity to an amount that will be sufficient for proper lubrication, but will not admit of a wasteful or unnecessary amount.

We recommend the box to be made with circular bottom, as it has all the advantages that have already been discussed relative to that point; at the same time it is recommended to allow the square bottom to come under the list of standards for any who may prefer this bottom, either for a larger oil capacity or other preference.

We desire to call attention to the fact that the box, wedge and brass as described will interchange with the box, wedge and brass now in use on about fifteen thousand 100,000-lb. capacity cars, which are practically all the cars of this capacity now being operated.

In the preparation of the drawings the notations made on them allow of the same elasticity in preference to materials, etc., as was decided and adopted in the case of the same parts for the 80,000-lb. car.

(To Be Continued.)

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.

Thirty-third Annual Convention.

Abstracts of Reports.

POWER TRANSMISSION BY SHAFTING VS. ELECTRICITY.

Committee—George Gibbs, F. Mertsheimer, William Renshaw, W. A. Nettleton, R. A. Smart.

A comparison of the relative advantages of electric and shafting driving for shop use may be made under the following general headings:

1. Relative economy in cost of power itself.
2. Relative convenience of operation and installation.
3. Relative effect upon shop output and cost of labor.

Referring in detail to the scope of these considerations:

1. Economy.—This has been taken to comprehend only the relative cost of operating the two systems, including expense for fuel, attendance, repairs, interest on investment and depreciation. It is the reason most generally advanced for the installation of electric power, but can only be the controlling one where the cost of power is a large proportion of the shop running expenses.

In order to compare the relative efficiencies of engine and electric transmission, it will be necessary to subdivide the character of shop plants somewhat. To do this completely would lead to endless complication, but for present purposes the typical plants are:

1. Shop plant in which each building has its own power plant.
2. Shop plant in which all buildings are furnished with power from a central source.

The manner of connection from the prime mover to the tools may be assumed, for an extreme comparison, in either of two ways, namely: (a) shafting method; (b) individual tool-driving method.

Taking the first condition, the average efficiency from engine to tools for steam engine transmission is shown elsewhere to be 50 per cent.; for electric transmission, under condition "a," the shafting losses will be reduced by splitting up long lines and by avoiding cross-belting, so that they will not exceed 20 per cent., or an efficiency of 80 per cent.; and in the electrical elements, as before shown, the efficiency from engine to shafting is 65 per cent.; therefore the final transmission efficiency will be, $80 \times 65 = 52$ per cent., as against 50 per cent. in the purely mechanical method; or, practically, a stand-off. Under condition "b," much less shafting will be employed, and the electrical portion may also show a better all-day efficiency, under certain conditions, by the shutting down of idle machines—say, a shafting efficiency of 90 per cent. and an electrical efficiency of 66 per cent., or a resultant of 60 per cent.—showing a small gain for the electrical method.

Taking the second condition and assuming an unfavorable condition for shafting transmission, as in case of a shop having each building with its own boiler plant and one or more engines, and compare this with a case of a central power plant for electric transmission to all buildings, the possible fuel saving in the latter arrangement will result first, from some small saving in power required for each individual building, as before shown, and second, from some very considerable saving due to the better efficiency of a large engine and boiler plant over that of several small ones. In extreme cases, where large condensing engines displace small non-condensing ones, and in large stations having a uniform load, the fuel saving may readily approximate 33 1/3 per cent., as is shown in an actual case cited elsewhere.

Attendance.—The item of attendance will next be considered. It is made up of three classes of labor—engineers and firemen; care of shafting and belting; electrical repairs. In an electric system the costs can be reduced by consolidating the engine and boiler plants and by the elimination of large and heavy belts, large shaft bearings and the consequent danger from overheating, reducing labor probably one-half; but a new item of expense in care of electric machinery will be introduced, which will about offset the other items, leaving the whole attendance bill practically unaffected by the introduction of electric shop power in plants of any considerable size.

Repairs.—As to repairs of shafting and belting it is difficult to obtain accurate data, the record of these items being seldom kept separately in shop accounts. The records of one large establishment have, however, been examined by your committee and the saving found in these items, under the electric driving system, is found to be more than sufficient to pay for all repairs to motors and lines. Thus the conclusion seems justified that the repair item will not be materially different under either system of driving.

Interest.—The remaining items of power-cost are depreciation and interest on investment. It is difficult to institute a fair basis of comparison between the first cost of an electric and a steam transmission plant, for the reason that the results sought to be accomplished by the former provide additional shop facilities, and are therefore not rightly chargeable in a substitution sense. Considering, however, the case of simple substitution in a single shop, where the power plant and arrangement and number of tools is retained as before, electric driving is certain to involve a largely increased first outlay—approximately double that for shafting method. But in a modern shop plant other considerations are the guiding ones in selection of the power system, such as the possibility of labor-saving devices, cranes, etc., and the greater cost of the electric system becomes a rightful charge against the advantages so obtained.

Dropping, therefore, any attempt to draw a strict comparison between first costs, it may be said that in estimating the total cost of power machinery it is usual to include an allowance for interest and for a sinking fund, with which to replace the plant when its utility is no longer on an equality with best practice. These items are generally figured together at 10 per cent. on first cost, a sum amounting roughly to one-fourth of the total running expenses of the power system.

Convenience and Shop Output.—These considerations are so closely inter-dependent that they can best be referred to together.

The ordinary shop plant with steam power transmission, both in the arrangement of building and of machines, is the slave to the limitations of this system; it must be laid out so that the shafting and engine connection is as direct and simple as possible; the machines must be compactly arranged in parallel lines, and the ceilings and columns designed with special reference to shafting supports. In other words, the tools must be installed with first reference to the application of power and not, as should be the case, with reference to handling the work to best advantage. Handling operations are of necessity largely by manual methods, and the shop buildings even must be located with first view to getting the power to them with the least awkwardness and expense.

While generalizing in this manner, your committee has not lost sight of the fact that handling and transferring machinery may be operated by other means than electricity, but it is equally true that devices of this nature are of limited practical application, and the broad fact remains that electricity is to be credited with ushering in a new era of labor-saving shop devices.

Electrical transmission places no restriction on the location of the machines, and each shop may be planned with a view to handling its product with least waste of labor and with greatest convenience of access to the tools. These may even be transported from place to place to the work; further, the partial or entire absence of overhead line-shafting insures better lighting of the shop and conduces to cleanliness. These factors promote cheerfulness and an improvement in both quantity and quality of output.

The clear head room permits the universal application of various forms of traveling cranes for serving the tools and for conveying operations, furnishing the most efficient means yet developed for increasing shop economy, and, as a means of communication between buildings, electric cranes and transfer tables have advantages over appliances of the same nature driven by steam and air.

Special Appliances.—In these electricity shares a large field with compressed air. It must be admitted that air devices have up to the present time received most attention at the hands of the railway mechanic, a fact in large part due to the lack of practical knowledge of the electrical specialist and to the greater cheapness of air tools. With, however, the general introduction of electric shop power plants and the better acquaintance of practical men with the agency, an extensive application of electric labor-saving devices is certain to result.

Flexibility.—The extension of a shop building or the tool equipment under the shafting system is generally a matter of much difficulty, and the attempt to add to such a plant often results in inconvenient crowding of the tools or to an overloading or complication of the shafting system, a fact which fully accounts for the extremely poor efficiency sometimes quoted for shafting transmission. In an electric system, on the other hand, great flexibility in extension is secured, as new buildings may be placed in any convenient position and additions made to the driving system without affecting the intermediate links.

TABLE No. 1.—POWER REQUIRED FOR MACHINE TOOLS.

Tool.	Nature of Work.	Horse-Power Required. Empty.	Light Load.	Full Load.	No. of Cutters.	Remarks.
70 in. wheel lathe	Wheel center	......	4.4	7.9	2	Light cut.
	32 in. wheel center	......	4.7	5.8	2	⅛-in deep cut.
	56-in. wheel center	1.5	5.2	6.2	2	
Horizontal lathe	56-in. wheel center	......	4.3	7.1	1	½ in deep cut.
Large double frame planer	Two frames	11.0	......	21.6	2	⅛-in. deep cut.
Slotter, 18 in. stroke	Frames	2.3	5.0	10.3	1	Heavy cut.
Slotter, 12-in. stroke	Wrought iron, 6 in. thick	1.5	2.1	6.5	1	
36-in. planer	Frames	3.4	4.2	7.4	1	
		3.4	......	11.3	2	
Drill press	1-in. drill, wrought iron	.97	1.94	2.9	1	
	1⅛-in drill, wrought iron	.97	1.92	2 2	1	
	2¼-in drill, wrought iron	.97	1.94	2 85	1	
Boiler-plate shears	$\frac{9}{16}$-in. plate steel	3.5	6.0	19.0	1	
Boiler-plate rolls	$\frac{11}{16}$-in. by 10 ft. 6 in. long, steel	4.5	11.4	19.8	....	
Jib crane, 10 ton, 10 h.-p. motor.	Lifting 10 tons	1 2	......	13.0		
	Lifting 7 tons	1.2	......	11.0	....	
Jib crane, 6 ton. 8 h.-p. motor	Lifting 6 tons	1.2	......	11.6	....	
Traveling crane, 5 ton	Lifting and carrying 4 tons	11.9	......	19.3	....	
Planer	Empty	3.4	......	..	....	
	1 tool	......	......	7.4	....	
	2 tools	......	......	11.0	....	
Shafting	Empty	15.0	......		....	
	6 planers	......	......	20.0	....	
	4 milling machines	......	......	26.0	....	
	2 lathes	......	......	30.0	....	
	1 buff wheel	......	......	34.0	....	
Planer and siding machine	6-in. oak flooring	8.0	....	32.0	....	Top and sides planed.
24-in. planer	12 in. yellow pine	2.5	......	11.0	....	Top only.
Molding machine	6½-in. yellow pine carlin	1.5	......	8 5	....	4 sides.
Daniel 30 in. head planer	Oak tender end sill	3.7	......	8.8	....	Cut $\frac{3}{16}$ in. off top
3-spindle boring mill.	Oak, 2-in bits	0.5	......	2.5	....	
Large tenoning machine	Oak end sills	3.0	......	7.0	....	¾-in. x 5-in. x 10-in. cut.
Circular rip saw, 28 in diameter	Oak, 9¼-in. by ¼-in. cut	1.5	......	20.0	....	
Band saw plate, 1⅛ in. wide.	Oak, 12 in. thick	1.5	......	6.0	....	

Speed Control.—The case of speed control between wide limits of certain types of electric motors is a valuable feature and will result in more frequently securing a greater adaptability of the tool to the work than is possible where a change in speed involves stopping the tool and shifting belts and gearing.

Increase in Output.—This constitutes, in the opinion of your committee, the chief claim of electric transmission to the attention of shop managers, and it follows from the previously mentioned facts, as, by the use of electric handling devices, the tool is quickly served with its work and the product placed in the most favorable position for operating upon and idle time cut down, and, by independent driving, the capacity is increased by reason of the perfect control of speed possible.

POWER REQUIRED TO DRIVE MACHINE TOOLS.

Data for power required for shafting and for certain tools may be found scattered through the transactions of various engineering societies, especially in the papers of Professor Benjamin, in the proceedings of the American Society Mechanical Engineers, 1896 and 1897, which give valuable figures; but the amount of exact information attainable anywhere is not very considerable. In the nature of things, figures for frictional losses in shafting must be exceedingly variable, and under the plan of connecting the shop power system to one main driving engine, there is no ready means of analyzing the figure of engine-indicated horse-power to determine the consumption of any particular section of shaft or of a single tool.

With the introduction of electric driving, however, the subject is becoming better understood, as it is a simple matter to connect a test motor to a shaft or tool and thus obtain figures from which to design a power plant for maximum efficiency.

Electric Efficiency.—An electric transmission plant varies in efficiency as follows:

Generators	86 to 90 per cent.
Transmission lines	90 to 95 per cent.
Motors	78 to 90 per cent.
Total final efficiency	62 to 77 per cent.

The above are figures for full loads on the different elements and the variation arises from the difference in sizes of units employed and in line losses assumed. At partial loads the machine efficiencies will drop, but the line efficiency will increase, so that the resultant will be nearly independent of the load. In fact, it is generally possible to shut down many of the separate motors when operating the plant at partial load, and the efficiency of transmission may thus actually increase under such conditions. In an average size of railway shop plant a resultant all-day efficiency of 65 per cent. from the engine to the motor pulley may be assumed.

Shafting Efficiency.—The average friction horse-power in heavy-machinery shops to drive belts and shafting, from engine to tool pulleys, as given by various authorities, varies from 40 to 55 per cent. of the total power used, and perhaps the round figure of 50 per cent. is as near the correct general average as the data will permit. Considering a separate shaft only, with compactly arranged tools, a better efficiency than the above can be assumed, and your committee concludes from a number of experiments with electrically driven line shafts that 20 per cent. fairly represents the average loss in shaft and counter-shaft bearings and belts on the tools, or an efficiency of 80 per cent.

Some authorities attempt to express the actual horse-power lost in friction per 100-ft. length of shafting and per counter-shaft and per belt, but while figures of this kind would be useful if approximately correct even, your committee has been unable to check them closely enough to feel warranted in quoting them.

As a rough guide in laying down shop power plants, it would appear that the horse-power of generating station required per man for railway shops will average about 4 h. p.

Table No. 1 gives a few examples from tests of the power required to drive typical railway shop tools, both for iron and wood working. The greater number of these results for metal-working tools were taken from tests at the Baldwin Locomotive Works, and for wood-working tools from Pennsylvania Railroad Company's tests.

Suggestions Upon the Manner of Installing an Electric Transmission Plant.

System.—Both direct and polyphase alternating current systems are applicable for shop use, and each system has its advocates among electrical engineers.

For long-distance transmission, say one mile or more, alternating transmission is almost a necessity; for shorter distances, and in cases of isolated plants in compactly grouped railway shops, the direct-current system can be employed without any practical disadvantages in waste of power in transmission lines.

Mechanically the induction type of alternating motor has great advantages in its simplicity and the absence of rubbing contacts. When it is said that probably 90 per cent. of all direct-current motor repairs are to commutators and brushes, the importance of this statement is clear. A further advantage in the induction motor is the strong mechanical design of the revolving element. This is built up of heavy copper bars firmly bolted to a cast center. The direct-current motor, on the other hand, is a complicated assemblage of small wires, made additionally weak by the necessities of installation.

The disadvantages of the alternating-current motor are its high speed and the fact that it is essentially a constant-speed machine. For driving line shafting, a constant-speed motor is entirely satisfactory, but for independent tool driving a variable-speed motor has unquestionable advantages.

If the alternating system is to be adopted, it is important to specify that the motors shall be of the "induction" type, as this is the only variety which is at all applicable for shop uses.

A further element of importance in the alternating system is that of "frequency" or number of alternations of the current per minute. It is difficult to give a positive recommendation as to the proper frequency without qualifications. Realizing, however, the importance of standardizing apparatus, your committee venture to suggest the specification of "3,000 alternations per minute" for adoption in railway shop plants. Alternating motors of this frequency are now in general use and have the very great advantage of fairly slow speed.

Voltage.—Direct-current generators are built for 125, 250 and 550 volts pressure, which, allowing for ordinary losses in lines, corresponds to motor pressures of 110, 220 and 550 volts respectively.

The 220-volt direct-current motor is practically the standard for shop purposes; the 550-volt motor is used for railway pur-

poses, but this pressure is indescribably high for shop use. Incandescent lamps may be obtained for 220-volt circuits, or the more common 110-volt lamp may be used on such circuits by connecting two of them in series. A 250-volt generator, together with 220-volt motors, are therefore recommended for shop plants.

Alternating-current motors are wound for either 220 or 440, and for similar reasons to the above, the 220-volt system is recommended.

Type and Size of Generator.—As between the direct-connected and belted machines the relative advantages may be thus stated: The direct-connected generator is more compact and more solid in construction, especially in small machines, due to the greater size of its parts. It is therefore more durable and somewhat more efficient on account of elimination of frictional losses in belting.

The belted generator has an advantage of cheapness in first cost, due to its higher speed, which means more output for the same amount of material; and the further fact, often of importance, its ready applicability to existing engine plants.

For generators of 75 h. p. or less, the belted machine answers every practical purpose, but above this size the purchase of direct-connected machine will be found an economy in all new plants.

In planning the installation of a transmission plant with small beginnings of running, say, one electric traveling crane, transfer table, turn-table outfit and a few portable tools, a 75 or 100 h. p. belted generator will be found a convenient unit size. It may be installed cheaply by belting from countershaft at the main shop engine, but it is altogether better to provide a separate engine, for the reasons that the electric drive may be needed twenty-four hours in the day for special work (such as roundhouse turn-table), and it makes a good emergency power plant for portions of the shops working overtime. It may be also used at night to light the roundhouse and other buildings. When the transmission plant outgrows the capacity of this generator, it may still be used as "spare" or for overtime work,

In laying out a complete system of electric transmission to displace engine and shafting transmission, careful attention should, of course, be given to selection of unit sizes. Little advice can be given offhand for such a case, as the determination of average and maximum loads is the basis of all calculations. In large plants, say of 500 h. p. or over, there should be two, and possibly three, units of the direct-connected type and selected so that the engines shall run as far as possible at economical loads, and that one unit may be out of service for repairs.

Calculation of generator capacity required can be made approximately from published data on power required to run machine tools. It is usual to install motors having a considerably larger nominal capacity than figured requirements, so that generator capacity need never be as great as the added capacities of motors attached. In fact, the generator load in an ordinary shop seldom runs above 50 per cent. of that of the combined motor capacity, and in shops having a large motor load the effect on generator of running a traveling crane, a transfer table and turn-table need not be considered, as the momentary overload capacity of the machine will be ample to take care of such requirements.

Rating of Generators.—Generators are sold with a guarantee to deliver their rated capacity, when driven at a certain speed, indefinitely, with a maximum temperature rise, due to electrical losses, of an amount supposed not to be injurious to insulation. This rise should not exceed 40 degrees Centigrade above the temperature of the surrounding air. They are also guaranteed to carry an overload of 25 to 50 per cent. for two hours, and short-period overloads of 100 per cent. without injurious heating. These guarantees have led to the objectionable but common practice of figuring the engine size on the overload capacities; that is, it is quite customary to couple a generator to an engine having its economical rated capacity equal to the 50 per cent. overload capacity of the generator. The consequence is that load is piled on the generator as long as the engine will pull it without seriously dropping off in speed, and an expensive generator is finally ruined for lack of the common-sense precaution which would be furnished by a properly adjusted engine unit.

Motors.—If the direct-current system be adopted, a wide range of selection in motor types is possible.

For line-shafting, motors should be of the shunt type.

For individual tool driving, the shunt motor is also in most common use; but the compound-wound variable speed motor is recommended as a desirable substitute. In fact, it is the belief of your committee that one of the great advantages of electric driving is in the possibility of simple speed regulation for large tools, and the attention of the electrical companies should be called to the importance of filling this requirement in their line of standard motors.

Motors are preferably of "open" construction; that is, with the ends of field frame uncovered. Where exposed to the wet or to mechanical injury from articles falling into it, the closed type of motor may be employed, but this type is not desirable where it can be avoided on account of its lack of ventilation, which means overheating unless the motor is of relatively large size for the work to be done.

For traveling cranes, hoists, transfer tables, locomotive turntables and boiler shop plate rolls, which start under load, run at variable speed, stop and reverse, the series-wound motor is the best, and is preferably of the enclosed style, which allows of more universal connection in any position, by gearing or otherwise, than the open type, and the question of heating is not so serious, on account of intermittent running.

For alternating motors, the same considerations as for the "direct" apply; but, as elsewhere explained, variable speed running in this type for tool-driving motors is not practicable. For crane work, however, the induction motor is successfully applied by attaching speical controlling devices.

In selecting motors, the importance of keeping down the number of sizes should be had in mind. This should be done at the expense of some increase in first cost and in spite of some waste of power due to reduced efficiency of underloaded motors, especially as their reliability is thereby enhanced. Competition among the makers of cheaper grades of motors has resulted in giving ratings dangerously close to the maximum safe working limit, and with all motors a reduction in the working load greatly increases their durability.

In deciding upon the make of motor to be purchased there is the same range for selection as found in other lines of machinery; but as an electric motor is a somewhat delicate machine, it is important to select only those made by reliable manufacturers. Such can be had of several companies, but they are not the lowest in first cost, and, in absence of definite information, it is generally safest to avoid very cheap machines. Even the best manufacturers make motors with different ratings as to speed and heating limits, and the lowest speed and lowest heating limit motors should be selected. This latter should not exceed 40 degrees centigrade rise above external temperature at continuous full load run. The speed should be the so-called "slow-speed" variety. Table No. 2 gives about the proper speed for each of the standard sizes of shunt motors. It also gives the approximate selling prices of the list, based upon the highest grade machines; price includes motor, with pulley, base-frame and belt tightener, and starting box.

A corresponding list of "medium-speed" motors may be obtained, the speed for a given power being about 50 per cent. higher than given in table, the prices being about 20 per cent. less on smaller and 35 per cent. less on larger sizes.

TABLE NO. 2 -SPEED AND PRICES OF SLOW-SPEED DIRECT-CURRENT MULTIPOLAR MOTORS.

Rated Output, H.-P.	Speed, R. P. M.	Price.	Price per H.-P.
2	1,200	$135	$67
3½	1,050	190	55
5	950	240	48
7½	850	310	41
10	750	400	40
15	650	500	33
20	600	600	30
30	575	850	28
40	550	1,050	26
50	550	1,200	24

Manner of Tool Driving.—This varies in accordance with the motor arrangement and may be by

(a) The group system.

(b) The individual system.

The selection of one or the other system depends upon the size of the tools and the consideration of intermittent or continuous running. In general, where the tools require less than three-horse-power each, it is best to drive them in groups from short-line shafts, which, as a rule, should not require more than 25 horse-power per shaft group. Where, however, three horse-power or over is required, or where variable speed or intermittent running is desirable, each tool should have its own motor.

In the group system the motor may be either belted to or direct-connected on the end of the line shaft, accordingly as space or plant cost permits.

In individual driving either belted or geared motors are employed. The belted arrangement is somewhat clumsy, but reduces shock and prolongs the life of the motor, and is, in the opinion of your committee, the better arrangement for general use.

Conclusions.

1. In a small shop, consisting of practically one building, having an equipment of small tools for light work only, electric transmission will not be found a paying investment. In such a shop, however, an electric lighting dynamo will be a convenience, and may be utilized to run a few labor-saving electric tools, such as a cylinder-boring outfit, a turn-table motor, etc.

2. In an extensive railway shop plant the installation of a central power station and electric transmission will always be found advisable, as it will not only result in the most economical system in respect to operation, but will make possible far more important shop economies, namely, an increase in quantity and quality of output and a reduction in cost of handling the same.

SUBJECTS FOR 1901.

Committee—R. Quayle, G. W. Rhodes, F. D. Casanave.

FOR COMMITTEE WORK DURING THE COMING YEAR.

1. What is the most economical speed for freight trains?
2. Different types of locomotive fire-boxes now in use, and most promising type for passenger, freight and switch engines?
3. What is the cost of running high-speed passenger trains?
4. The most satisfactory method of handling, cleaning and setting boiler tubes?
5. What is the most promising direction in which to effect a reduction in locomotive coal consumption?
6. What should be the arrangement and accessories of an up-to-date roundhouse.
7. Maximum monthly mileage that is practicable and ad-

visable to make; how best to make it, both in passenger and freight service?

8. What is the most approved method for unloading locomotive coal, prior to being unloaded on the tank?

WHAT CAN THE MASTER MECHANICS' ASSOCIATION DO TO INCREASE ITS USEFULNESS?

Committee—T. R. Browne, G. M. Basford, L. R. Pomeroy.

This report embodied suggestions for possible improvements in the methods now used by this Association and are summed up in the following:

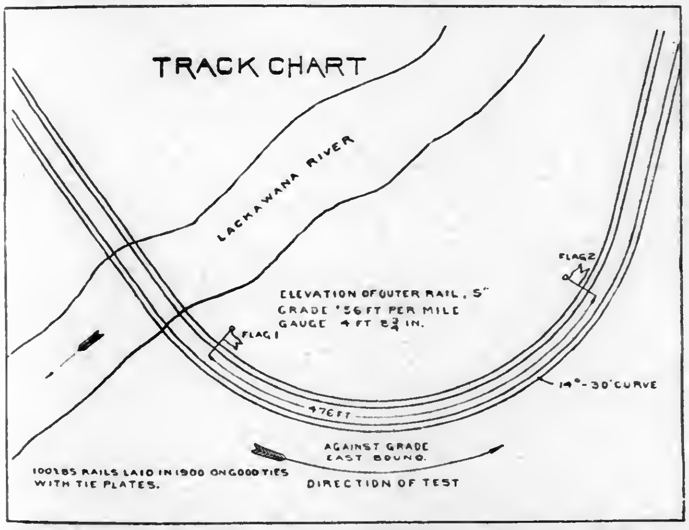
A nomination of officers by a nominating committee; an improved method of admitting associate members; the taking of record votes on questions of practice; more preparations for the introduction of discussions, and more complete plans for their consideration; the abolition of the universal practice of appointing as chairman of a committee the member who suggests the subject for committee investigation to the committee on subjects; recommendations to the president by the committee on subjects of members best qualified to present them; committees of investigation composed of small numbers of individuals; provision for the reception of individual papers; strict adherence to the rule requiring the presentation of long papers by abstract; the co-operation of railway clubs and special organizations in the presentation of opinions on practice, and in the suggestion of subjects for investigation; more explicit instructions to committees as to arrangement, and advancing conclusions in reports; the appointment of several additional standing committees on subjects concerning motive power progress; increased responsibilities of the committee on subjects in the actual work of the convention; provision for a thorough printed index of the proceedings of the Association from the first volume; an effort to make the reports presented to the Association thoroughly reliable; a typographical arrangement of reports which will render the conclusions and decisions more easily found; the establishment of a library similar in plan to that of the Western Railway Club.

FLANGED TIRES.

Committee—S. Higgins, W. H. Thomas, Wm. Garstang.

"Is it desirable to have flanged tires on all the drivers of mogul, ten-wheel and consolidation engines? If so, with what clearance should they be set?"

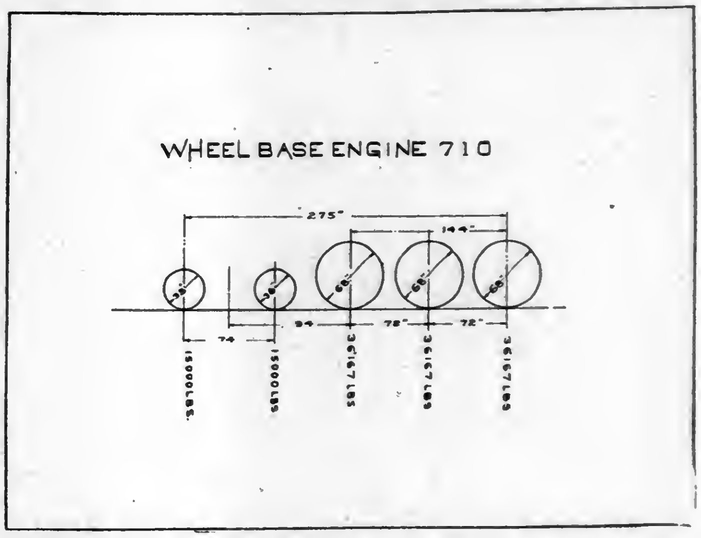
The original report presented one year ago contains the results obtained at that time, which results the committee did not consider to be conclusive on account of the difficulty



experienced in taking the readings of the dynamometer that was placed between the engine being tested and the engine doing the work. The results now presented, in the opinion of the committee, can be taken as conclusive and reliable in every respect, inasmuch as they were obtained with a self-registering dynamometer car of approved construction, the operation of which will be explained further on in the report.

For information concerning present practice as to tire arrangement on mogul, ten-wheel and consolidation engines the members of the Association are referred to the first report.

The committee met in Buffalo, N. Y., last fall, and the meeting was attended not only by the members of the committee, but also by representatives of the Roadway Department. At that meeting it was decided to do the work with a self-registering dynamometer car, the tests to be made on the line of the Lehigh Valley Road at the same place where the tests were made one year ago. The tests to include not only a consolidation engine, but also an engine of the ten-wheeled type. It was furthermore decided that the track on which the tests were to be made should be put in first-class shape with elevation and gauge on curve to represent what is the average practice at the present time. It was decided that a test should be made with ten-wheel type of engine, and with each tire arrangement, on straight track to ascertain the lateral motion of the engine. It was agreed that both engines to be tested should be engines just out of the shop with the



lateral motion between hub of wheel and box 1/16 in. on each side.

The diagram accurately represents the track on which tests were made, the track used being the right-hand or east-bound track, and the flags shown on diagram represent the points between which the readings were taken.

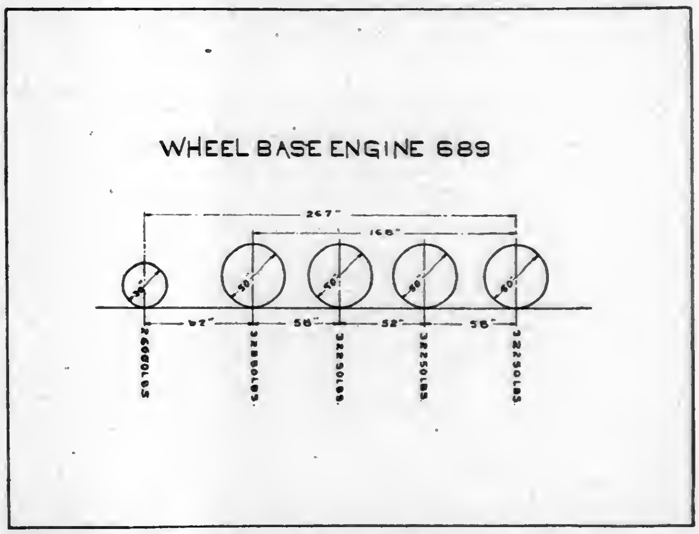
The lateral motion of the ten-wheel engine on straight track with each tire arrangement was determined with an instrument known as a hydrokinetimeter. As before stated, dynamometer tests were made with a consolidation engine, also with an engine of the ten-wheel type.

With both engines main rods and valve rods were disconnected, boiler and tender cisterns were full of water, and there was about two tons of coal on each tender.

The dynamometer tests were made by hauling the engine to be tested through the curve, entering at the lower end so as to have the grade (56 ft. to the mile) to contend with, at speeds approximating ten, twenty and thirty miles per hour for each engine, with each tire arrangement. The start was made at a sufficient distance from the first flag, to enable the engineer to get the test train at the desired speed when passing that flag. The test trains were made up in the following order: First, Engine hauling train; Second, Dynamometer car; Third, Engine being tested. The couplings were blocked with wooden wedges, to take up the slack.

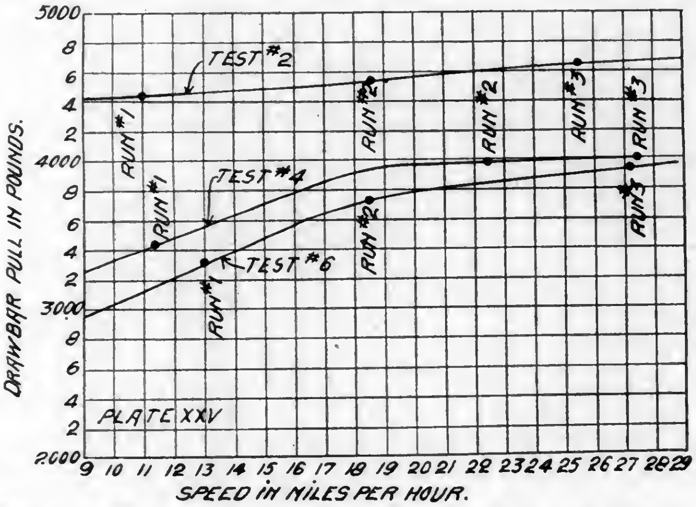
The hydrokinetic tests were made between two semaphores, 2.63 miles apart, on straight and level track. In making the tests the train was started at the first semaphore, and brought to a speed approximating forty miles per hour, which was maintained until the second semaphore was passed, when the train was gradually brought to a stop.

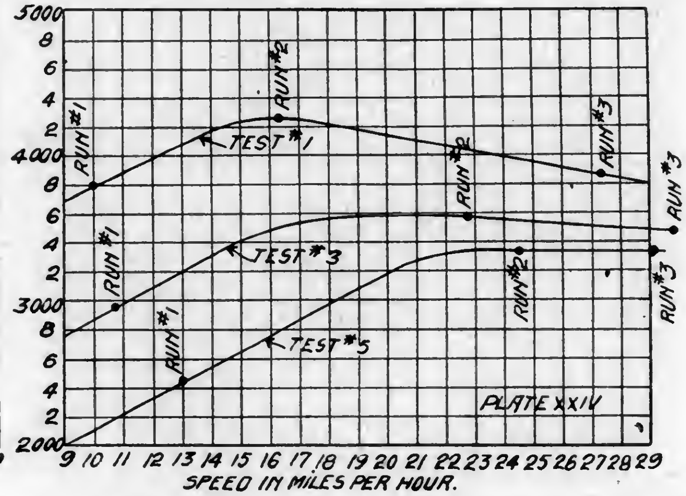
Three series of dynamometer tests were made with each



engine, or six in all. The first test was made on the morning of April 10, and the tests were finished on April 12. The distance between backs of flanges on engine truck wheels in all tests was 53¼ in. The distance between backs of flanges on driving wheels, in all tests except No. 6, was 53¼ ins. In test No. 6 the distance between backs of flanges on front and back pair of drivers was 53⅛ in., while this distance for the middle drivers was 53¼ in.

The plain tires were located on driving-wheel centers so that the center of the tread of tire coincided with the center of the rail head on straight track. Tires used were Master





Mechanics' standard section, flanged tires 5¾ in. wide, plain tires 6½ in. wide.

The records obtained in the dynamometer test are shown in the table at the end of this report. A comparison of results of the tests on engine No. 710 is shown on Plate 24, and on engine No. 689 on Plate 25 (reproduced here). The results obtained from engine No. 710 by the hydrokinetic tests are shown on Plate 26, reproduced as follows:

HYDROKINETIMETER TESTS, ENGINE 710.

Test Number.	1	3	5
Average speed, miles per hour..................	30.86	34.15	33.4
Maximum speed, miles per hour..............	40.00	40.60	38.90
Height of float at start, inches	12	12	12
Volume of water at start, cu. in	3096	3096	3096
Height of float at finish, inches	6 9/16	6⅛	6 3/16
Volume of water at finish, cu. in	1693.13	1580.25	1596.27
Volume of water displaced, cu. ins	1402.87	1515.75	1499.63
Per cent. of water displaced	45.32	48.96	48.41

Test No. 1 was made on the 10-wheel engine with rigid truck and forward drivers plain. In all the other tests swing motion trucks were used. Test No. 2, consolidation, had second and third pairs of tires plain. Test No. 3, 10-wheel engine, had plain tires on the middle drivers. Test No. 4, consolidation engine, had plain tires on the second pair of drivers. Tests 5 and 6, 10-wheel and consolidation respectively, had flanged tires on all wheels.

The hydrokinetimeter consists of a reservoir 18½ in. in diameter, 12 in. deep, with a copper float in the center to permit of accurate measurement of the volume of water displaced; the different volumes of water displaced indicating the lateral motion of the engine as affected by the different tire arrangements, and before starting it was filled with water. At the end of the run the water remaining in the instrument was measured and the difference represented the volume of water displaced. The instrument was bolted on top of the fireman's shield, which is fastened to the top of the back boiler head.

The results obtained justify the members of the committee in concluding that it is desirable to have flange tires on all the drivers of mogul, ten-wheel and consolidation engines. With mogul and ten-wheel engines the tires should be set so that the distance between the backs of flanges will be 53¼ in. With consolidation engines the tires on front and back pairs of wheels should be set so that the distance between backs of flanges will be 53⅛ in.; with the other two pair of drivers the tires should be set so that the distance between backs of flanges will be 53¼ in.

It should be understood that the committee assumes that the engines will have swinging trucks.

SUMMARY OF DYNAMOMETER TESTS.

ENGINE 710 (10-WHEEL).

Test No. 1.			Test No. 3.			Test No. 5.		
Run.	Speed, m. p. h.	Load, lbs.	Run.	Speed, m. p. h.	Load, lbs.	Run	Speed, m. p. h.	Load, lbs.
1.........	9.967	3,780	1	10.90	2,970	1........	12.975	2,450
2	16.200	4,260	2.	22.95	3,560	2....	24.500	3,350
3	27.275	3,860	3	29.70	3,170	3	29.150	3,327
Ave'ge .	17.814	3,967	Ave'ge...	21.183	3 333	Ave'ge.	22.208	3,042

ENGINE 689 (CONSOLIDATION).

Test No. 2.			Test No. 4.			Test No. 6.		
Run	Speed, m. p. h	Load, lbs.	Run.	Speed, m. p. b.	Load, lbs.	Run.	Speed, m. p. h.	Load, lbs.
1.........	11.030	4,440	1.........	11 330	3,410	1	13.083	3,300
2.........	18.610	4,510	2 .. .	22 675	3,990	2	18.600	3,730
3.....	25.700	4,640	3.........	27.550	4,060	3........	27.325	3,940
Ave'ge..	18.790	4,510	Ave'ge ..	20.518	3,830	Ave'ge.	19.669	3,657

BEST TYPE OF STATIONARY BOILERS FOR SHOP PURPOSES.

Committee—J. F. Dunn, J. J. Ryan, John Hickey.

For a medium-sized steam plant, such as is ordinarily required for a railroad repair shop, a well-constructed and properly set horizontal tubular boiler with fire-brick lining gives very good and economical results under varying conditions of water, fuel and the average fireman, where the steam pressure to be carried does not exceed 125 lbs. per square inch and simple non-condensing engines are to be used; as in a properly constructed return tubular boiler, the radial surface of the shell exposed to the action of the fire is accessible, and the interior can easily be kept clean, and the heating surface of the shell exposed to the fire does nearly 50 per cent. of the total work of the boiler.

With water-tube boilers, the heating surface being almost entirely confined to the tubes, the insoluble salts are deposited and adhere to the interior surface of the tubes in spite of the vigorous circulation claimed for this type of boiler, but the introduction of soda ash and lime into the feed-water will, of course, act equally as favorable in this type of boiler as in the others in the prevention of scale forming, and while ordinarily it might be considered a difficult matter to keep such tubes clean, and that the cost of maintenance might be greater owing to the liability of the tubes leaking where set in the headers and uptakes, yet all reports received by your committee indicate the contrary when fairly good feed-water is used, and invariably those who have used this type of boiler mention it very favorably, especially the type having straight tubes (without bends) that are easily accessible at both ends. It is doubtful, however, whether the water-tube boiler can show much better efficiency than a properly designed and properly set return tubular boiler under all conditions. If, however, the magnitude of the steam plant is designed for compound condensing engines a properly constructed, first-class water tube boiler may be preferable to the return tubular for the reason that it is economical to carry steam at a higher pressure on compound engines than has heretofore been the practice with the return tubular boiler. It appears to be the prevailing practice at the present time, especially so in large steam plants, to use water-tube boilers capable of carrying a working pressure of 180 to 200 lbs. per square inch in connection with compound condensing engines, as, with the water-tube type of boiler, its heating surface is considered more effective because of having the heating surface made of very much thinner material than is possible with the return tubular boiler designed to carry such a high pressure.

Another important point claimed for the water-tube boiler is its comparative freedom from disastrous explosions in comparison with the various other types owing to the subdivision of the water spaces into smaller volumes, or areas, and that repairs can be made much quicker on account of not having to wait so long for boilers to cool down as with the return tubular type, owing to the heat contained in the shell and brick settings of the latter; and the ordinary repairs in the former generally consisting in the renewal of a tube, header or uptake, which can be replaced in much shorter time than patching the shell of return tubular boilers, which quite often necessitates removing a portion of the brick settings. It seems to be generally conceded, however, that the return tubular type furnishes the drier steam.

The locomotive type of boilers with internal firebox deserves some mention on the following point of merit, namely, they are portable, which permits of their being easily removed from one point to another, and are a type with which the average shopmen are familiar and can readily make repairs, and it requires no expensive brick settings, taking up less room than either the return tubular or water-tube type, and the heat from the fuel is absorbed entirely by the heating surfaces of

the boiler; whereas with the return tubular and water-tube type, the brick walls enclosing the boilers absorb and radiate considerable of the heat. However, your committee does not consider them as economical on fuel as the other types mentioned, for the reason that as a rule quite a portion of their heat-radiating surfaces are exposed to the varying conditions and changes of atmosphere, thereby causing loss of heat by radiation. They also require more attention in firing, owing to the limited grate area, and as a whole the locomotive type of boiler is much more expensive in construction in maintenance than the return tubular type and can only be recommended to be used as is the generally prevailing custom, namely, utilizing such boilers as a temporary expedient as are discarded from locomotives.

It appears that the general practice is to use tubes 3 in. in diameter for hard or anthracite coal; 3½-in. tubes for first quality bituminous or high-grade soft coal, and 4-in. tubes for low-grade bituminous coal; the tubes being not less than 12 nor more than 18 ft. in length. The ratio of grate area to heating surface for return tubular boilers with a natural draught, using ordinarily good bituminous coal as fuel, is about 1 sq. ft. of grate area to 35 sq. ft. of heating surface, and for water-tube boilers, with like conditions, the mean average ratio is practically 1 sq. ft. of grate area to 45 sq. ft. of heating surface; but with anthracite coal the ratio is somewhat less, and the mean average ratio of heating surface per horse-power averages 12½ sq. ft. for return tubular boilers and 10 sq. ft. for water-tube boilers.

Your committee regrets that it is not prepared to make any recommendations as to preference between the return tubular or water-tube type of boilers, and simply mention that either type is both efficient and economical under the conditions as mentioned in the foregoing report. The important factor governing either type is to have it of adequate capacity to meet the varying demands of the load without having to be forced to its maximum capacity, at which point any type of boiler ceases to be economical. It is also desirable to have as large a grate area as practicable within reasonable limits, to permit of burning slack or refuse coal, and the smokestack should be of ample area in both diameter and height, as a good draught and consequent greater heat tends to more perfect combustion, especially of the volatile part of the fuel, of which almost all American bituminous coals contain a large amount.

Another very important factor of which the members of this Association are cognizant, but which quite often is not given the attention its importance deserves, is the matter of keeping boilers, including the brick walls (of the settings), tight and free from leaks and the interior of the boiler as clean as possible under existing conditions, as a very small leak in the boiler will very often materially affect the evaporative efficiency, and the leak, if only a simmer, if allowed to continue, forms corrosion which eats the plates away and eventually necessitates the application of a patch, which could be prevented by a few minutes' caulking at the start.

(To Be Continued.)

INCREASE IN THE USE OF THE PINTSCH LIGHTING SYSTEM.

At the close of each year it is the custom of the Julius Pintsch Company of Berlin, Germany, to make a report showing the number of cars that have been equipped in the various countries with the Pintsch system of gas lighting; also the new buoys supplied for harbor and channel lighting, and the number of gas works that were erected during the past twelve months.

The report for the year closing December 31, 1899, showing the progress made with the Pintsch system, which is now in use in twenty-one countries for lighting cars and buoys, has just been received and is printed below. It is evident from the large number of cars equipped in the year 1899, which are 7,292, that there is a constant extension of this system of car lighting by roads that some years ago adopted it, and also a rapid adoption of the system by smaller roads, which have postponed making a change from oil to gas.

Statement for 1899.

	Cars.	Locomotives.	Gas Works.	Buoys and Beacons.
Germany	36,305	3,784	71	98
Denmark	45	....	3	21
England	18,290	18	87	236
France	5,425	....	22	238
Holland	3,166	114	9	60
Italy	1,528	....	4	15
Switzerland	380	9	1	....
Austria	3,211	....	10	1
Russia	2,275	57	13	13
Sweden	475	8	4	2
Servia	154	....	..	....
Bulgaria	33	....	1	....
Turkey	103	....	..	....
Egypt	2	....	3	112
Canada	49	....	2	46
Brazil	974	31	1	31
Argentine	1,041	....	10	2
Chili	46	....	1	....
India	7,744	....	10	....
Australia	2,053	....	3	29
United States	14,883	....	51	134
Total	98,182	4,021	306	1,038
Increase for the year	7,292	367	3	146

The new locomotive equipments furnished in the various countries in 1899 were 367. These are used almost exclusively in Europe, and, in fact, all but 31 were for European roads, the 31 being supplied to railroads in Brazil. There were three new Pintsch gas works erected in 1899, and 146 new buoys and beacons supplied to the various governments. The total number of cars now equipped with Pintsch gas throughout the world foot up to 98,182. These figures, as before stated, were up to December 31, 1899, and it is safe to say that there are now throughout these 21 countries over 100,000 cars so equipped. The total number of locomotives now figure up to 4,021; gas works, 306; and buoys and beacons 1,038. These figures are interesting and speak well of the satisfaction that results from the use of the Pintsch system.

EXHIBITS AT THE CONVENTION.

The following is a list of the exhibits at the Mechanical Conventions at Saratoga, N. Y.:

Adams & Westlake Company, Chicago, Ill.—Exhibited Adlake acetylene gas car lighting system.

American Balance Slide Valve Company, Jersey Shore, Pa., and San Francisco, Cal—Exhibiting American balance slide valves for locomotives, marine and air engines and American balanced piston valves.

American Brake Company, St. Louis, Mo.—Locomotive brakes and engine truck brakes, automatic slack adjuster.

American Brake Shoe Company, Chicago.—Exhibiting brake-shoes.

American Car & Foundry Company, St. Louis.—Canda box car, designed for 100,000 pounds' capacity; Canda self-clearing wooden gondola car, designed for 100,000 pounds capacity; D. L. & W. structural steel hopper car, class S. H. 50, for coal and ore, designed for 110,000 pounds' capacity.

American Carbide Lamp Company, Philadelphia.—Exhibit of lighting device in Boston & Albany car No. 84 at foot of Washington street.

American Locomotive Sander Company, Philadelphia, Pa.—Pneumatic track sanders—Leach, Houston, She, Curtis and Dean.

American Steam Gauge Company, Boston, Mass.—Standard locomotive gauges with rigid or hanging non-corrosive movements, Duplex air brake gauges, pop safety valves, original Thompson improved indicators.

American Steel Foundry Company, St. Louis, Mo.—Exhibiting models of steel trucks and body bolsters.

Armstrong Bros. Tool Company, Chicago, Ill.—Complete line of planer and machine shop tools.

Atlantic Brass Company, New York, N. Y.—A. B. C. journal bearing.

Atlas Railway Supply Company, Chicago, Ill.—Samples of Atlas primer and Atlas surfacer, made under the Thomas S. Vaughn formula for passenger cars and locomotives; also their I. X. L. composition forall kinds of wood and ironwork.

Automatic Air & Steam Coupler Company, St. Louis, Mo.—Model of the device.

Automatic Track Sanding Company.—Manufacturers pneumatic track sanders, both hand and pneumatic, for all classes of locomotives, Boston, Mass.

Ball Bearing Company, Boston, Mass.—Ball bearings.

Baltimore Ball Bearing Company, Baltimore, Md.—Ball side bearings.

F. W. Bird & Son, East Walpole, Mass.—Torsion proof car roof.

Bierbaum & Merrick Metal Company, Buffalo, N. Y.—Lumen bronze, car bearings, side rod brasses, etc.

R. Bliss Manufacturing Company, Pawtucket, R. I.—Wood's platform gate for steam, elevated and street cars; Crone's patent air gate for steam and elevated railways.

Boston Artificial Leather Company, 12 East Eighteenth street, New York.—Car seats covered with moroccoline, strips of moroccoline in different colors and grains.

Boston Belting Company, Boston.—Samples of air brake, steam and car heating hose, mats, matting.

Bradley Company, Syracuse, N. Y.—Bradley hammers and forges.

Butler Drawbar Attachment Company, Cleveland, O.—Tandem attachments.

Carborundum Company, Niagara Falls, N. Y.—Carborundum wheels; also Yankee drill grinders and specialties, cloth and paper.

L. C. Chase & Co., Boston, Mass.—Exhibiting complete line of Chase plushes, made at the Sanford mills, consisting of plain and frieze goods; also a new line of artificial leathers.

Chicago Pneumatic Tool Company, Chicago, Ill.—Exhibiting Chicago reversible drills in five different sizes; Boyer drill, two sizes; Chicago rotary drill, four sizes; flue cutters, flue welders, Chicago piston breast drills, Chicago rotary breast drills, 10-horse-power motor, Boyer long stroke riveting hammer, Boyer clipping and calking hammer, shell riveters, Boyer speed recorder, Chicago sand rammers, Chicago painting machine, Chicago oil rivet forges, Boyer yoke riveters, Chicago staybolt biter, Chicago staybolt chuck, Ford dolly bars, pneumatic holder-on.

Chicago Grain Door Company, Chicago, Ill.—Grain door, security and lock brackets.

Chicago Railway Equipment Company, Chicago, Ill.—National hollow, Kewanee, Diamond and Central brakebeams, automatic frictionless side bearings, and have a specially adapted brakebeam for high-speed brake service.

Cleveland City Forge Works, Cleveland, O.—Turnbuckles and drawbar pockets.

Cloud Steel Truck Company, Chicago, Ill.—Cloud pedestal truck, Cloud pressed steel archbar truck, Bettendorf I-beam body and truck bolster.

Consolidated Car Heating Company, Albany, N. Y.—Exhibiting steam, hot water and electrical car heaters.

Consolidated Railway Electric Lighting & Equipment Company, New York, N. Y.—Model of the system of lighting cars by electricity generated from the axle; also a private car equipped with this system of electric lights and fans in operation.

Crosby Steam Gauge & Valve Company, Boston, Mass.—Waterback locomotive gauges, muffler and plain pop valves, chime whistles, spring seat globe and axle valves, Johnstone blow-off valve.

Curran & Burton, 70 Kilby street, Boston, Mass.—Exhibiting the Huff track sanding device, Huff automatic steam blower, Huff auxiliary variable exhaust.

Curtain Supply Company, The, Chicago, Ill.—Exhibiting Burrowes and Forsyth "roller tip" and Acme and Climax "cable" car curtains and fixtures.

Dayton Malleable Iron Company, Dayton, O.—Five draft riggings, complete, of four different types, single and double spring with malleable iron and wooden draft sills.

Frank S. De Ronde Company, New York and Philadelphia.—Lythite paint and painting machinery.

Detroit Lubricator Company, Detroit, Mich.—Detroit lubricators with the Tippett attachment, back pressure values for steam chests.

Drexel Railway Supply Company, Chicago.—The Schroeder grain door and Cardwell brakeshoe.

Dunlap & Plum, Columbus, O.—The U. & W. piston air drill.

O. M. Edwards, Syracuse, N. Y.—Window fixtures.

Fairbanks Company, New York, N. Y.—Exhibiting Fairbanks valves, Merrell pipe machines, Oster stocks and dies, Nicholson compression coupling, Nicholson adjustable mandrel, Dart couplings and flanges, Durable wire rope, Walker magnetic chuck, vulcabeston packing, pneumatic drills.

Garry Iron & Steel Roofing Company, Cleveland, O.—Exhibiting revolving pneumatic crane and a pneumatic car jack.

Gem Manufacturing Company, Pittsburg, Pa.—Gem oiler.

Gold Car Heating Company, New York and Chicago.—Car heating apparatus, duplex coil system and straight stem operated under steam; also various parts of apparatus shown separately.

Goodwin Car Company, New York, N. Y.—Steel model of car, full size section drawings and photographs.

Gould Car Coupler Company, 25 West Thirty-third street, New York, N. Y.—Showing passenger and freight slack adjusters, improved M. C. B. Journal box, model of the improved malleable draft rigging for freight equipment with spring buffer blocks; a quarter size model of the Gould vestibule continuous buffer, M. C. B. passenger coupler and improved steel passenger platform.

M. C. Hammet, Troy, N. Y.—Richardson balanced valves, link grinders and Sansom bell ringer.

Harrison Dust Guard Company, Toledo, O.—Exhibiting the Harrison dust guard in the four following sizes: 40,000, 60,000, 80,000, 100,000 pounds' capacity.

Hale & Kilburn, Philadelphia, Pa.—Pressed steel car seats.

Heywood Bros. & Wakefield, Boston and New York.—Exhibiting car seats, showing Wheeler, Henry and Bushnell makes, rattan parlor car chairs.

Illinois Malleable Iron Company, Chicago.—The Bruyn auto swinging smoke jack.

International Correspondence Schools of Scranton, Pa.—Demonstrating car in charge of W. N. Mitchell. Located on D. & H. track.

H. W. Johns Manufacturing Company, New York.—Full assortment of asbestos goods. Specialties in fire felt, locomotive lagging, Kearsarge gaskets and vulcabeston for piston rods; packing valves; stems and air brake packing rings.

Joyce, Cridland Company, Dayton, O.—Hydraulic jacks, geared lever jacks, screwjacks and single lever jacks.

Philip S. Justice & Co., Philadelphia, Pa.—Reliance hydraulic jacks.

Keasbey & Mattison Company, Ambler, Pa.—Magnesia locomotive lagging and train pipe covering.

Keystone Drop Forge Works, Philadelphia, Pa.—The Keystone connecting link. To take the place of a weld for connecting brake, guard or wrecking chains.

Koko Cream Company, New York.—Preparation for cleaning varnished surfaces and interior of cars.

Lappin Brake Shoe Company, New York.—Car and locomotive brakeshoes.

Leach & Simpson, Chicago, Ill.—The Ferguson locomotive fire kindler.

Locomotive Appliance Company, Kansas City.—Exhibiting model of Economic valve.

Lunkenheimer Company, Cincinnati, O.—Injectors, globe valves and swing check valves.

Manhattan Rubber Manufacturing Company, New York.—Air brake hose, rubber packing, Victor driving brake packing, hard rubber valves, gaskets, zigzag stitched belt.

Manning, Maxwell & Moore, New York City.—Metropolitan injector, Hancock single and double inspirators, boiler checks and main steam valves, intermediate swing checks for delivery pipes, duplex boiler check with inside stop valve, Ashcroft steam gauges and Consolidated safety valve.

McCord & Co., Chicago and New York.—McCord journal box, McCord coil spring damper, Johnson hopper door.

Michigan Lubricator Company, Detroit, Mich.—Michigan improved triple lubricator No. 3, and automatic steam chest plugs, also air brake cups.

Monarch Brake Beam Company, Detroit.—Monarch and solid brakebeams.

Moran Flexible Steam Joint Company, Louisville, Ky.—Large joints and all-metal steam-heat couplings.

National Car Coupler Company, Chicago.—Automatic car coupler.

National Elastic Nut Company, Milwaukee, Wis.—Exhibiting self-locking steel nuts.

National Railway Specialty Company, Chicago, Ill.—N. R. S. journal bearing key, Royal dustguard.

National Malleable Castings Company, Cleveland, O.—Tower couplers, Stevenson dustproof oil box and lid.

National Lock Washer Company, Newark, N. J.—Exhibiting the National sash lock.

New York Compressor Company, New York, N. Y.—One straight line and one duplex compressor.

A. O. Norton, Boston, Mass.—The Norton patent ball-bearing jacks and "sure drop" track jacks; also a full line of other jacks for all kinds of service.

The Pantasote Leather Company, New York.—Exhibit showing section of palace car fitted with pantasote curtains, head linings and upholstery.

Peerless Rubber Manufacturing Company, New York.—Air brake hose, steam hose, engine and tender hose, gas hose, packings, rubber matting, hose for pneumatic tools, etc.

Pearson Jack Company, Boston, Mass.—Pearson jacks, Pearson kingbolt clamp, Goodwin brakebeam clamp.

Penberthy Injector Company, Detroit, Mich.—Erwin steam ram.

Pneumatic Crane Company, Pittsburg, Pa.—Exhibiting self-propelling hoist and trolley, with unlimited travel and reversing air motor.

Powers Regulator Company, Chicago, Ill.—Temperature controlling apparatus.

Pressed Steel Car Company, Pittsburg, Pa.—Exhibiting N. Y. C. flat car; C. & A. flat-bottomed gondola, capacity 100,000 pounds; Great Northern hopper gondola ore car, designed to carry 110,000 pounds of ore; Erie hopper gondola coal car, designed to carry 110,000 pounds of coal, new type, having no side sills; P. R. R. hopper gondola coal car, with side sills, designed to carry 119,870 pounds of coal; also Buckeye truck frame.

Railway Appliance Company, Chicago.—Gilman-Brown emergency knuckle.

Rand Drill Company, New York, N. Y.—Rand compressor.

Roberts Car & Wheel Company, Three Rivers, Mich.—Pressed steel wheel, also an emergency air brake hose clamp.

Safety Car Heating & Lighting Company, New York, N. Y.—Exhibiting car lighting and heating apparatus. The new features are fancy deck lamps, bracket lamps, gas ranges for private cars and buoy lantern.

Schenectady Locomotive Works, Schenectady, N. Y.—One New York Central mogul, one Northern Pacific 10-wheel compound and one Northwestern fast express engine.

Simplex Railway Appliance Company, Chicago, Ill.—Simplex bolsters for 80,000-pound capacity cars, also same for 60,000-pound. Susemihl frictionless roller side bearing.

Smillie Coupler & Manufacturing Company, Newark, N. J.—Smillie improved coupler.

Standard Coupler Company, New York.—Standard steel platform and improved standard pressure coupler.

Standard Pneumatic Tool Company, Chicago, Ill.—Pneumatic drills, boring machines, pneumatic hammers, reversible boring machines, reversible flue rolling machines, chain hoists, reversible staybolt, reaming-tapping machines, long stroke riveters and yoke riveters.

Sterlingworth Railway Supply Company, Easton, Pa.—Exhibiting rolled steel car, Sterlingworth rolled steel truck, Sterlingworth rolled steel body and truck bolster and Sterlingworth rolled steel brakebeam.

Standard Paint Company, New York.—"Ruberoid" locomotive cab roofing, paints for iron or wood exposed to dampness or the action of acids or alkalies, preservative paints.

Standard Railway Equipment Company, St. Louis, Mo.—Pneumatic tools.

Star Brass Manufacturing Company, Boston, Mass.—Air and steam gauges, chime whistles, pop valves.

Thornburgh Coupler Attachment Company, Detroit, Mich.—Coupler attachments for all classes of equipment, either with single, double or triple springs, with or without metal draft arms.

United & Globe Rubber Manufacturing Companies, Trenton, N. J.—Exhibiting a full line of rubber supplies for railroad use.

Universal Car Bearing Company, Chicago.—Car bearings.

Universal Railway Supply Company, Chicago.—Car doors.

Walworth Manufacturing Company, Boston, Mass.—Ratchets, Stilson wrenches, stocks and dies; pipe taps, pipe vises, pipe cutters, nipple holders, Smith's railway track ratchet, steam whistles.

West Disinfecting Company, New York.—Disinfecting appliances.

Western Railway Equipment Company, St. Louis.—Combination lug and follower casting, Economy slack adjuster, tandem combination lug and follower, sill and carline pocket, bell ringer, Western flush door, interchangeable door, safety and security truck and casting, the Mudd sander, the Lindstrom non-freezing suction pipe, St. Louis flush door, Acme pipe clamps, Downing card holder, Acme tender pocket, lugless draft beam, side bearings.

J. H. Williams & Co., Brooklyn, N. Y.—Exhibiting car wrenches, track wrenches, hoist hooks, eyebolts, pipe wrenches and special forgings.

Woven Steel Hose & Cable Company, Trenton, N. J.—Exhibiting woven steel hose.

AMERICAN ENGINEER AND RAILROAD JOURNAL.

AUGUST, 1900.

CONTENTS.

"NORTHWESTERN" TYPE PASSENGER LOCOMOTIVE.

Chicago & Northwestern Railway.

The Schenectady Locomotive Works are building six most interesting passenger locomotives for the Chicago & Northwestern Ry., one of which was exhibited at the Saratoga conventions and is now in service. The wheel arrangement is that of the Atlantic type, but the features of the rear end are so unusual as to justify giving it another name, the "Northwestern" type. This engine has the largest amount of heating surface ever given to an engine of this wheel arrangement, and the grate area, due to the wide firebox, is the largest of which we have record, for a design intended exclusively for soft coal. We consider this engine as a remarkable step in the development of powerful fast passenger locomotives, and in order to do it justice we shall take it up again in our columns when performance records have been made, with a discussion of the prominent features of the design. At this time attention will be confined to the general features.

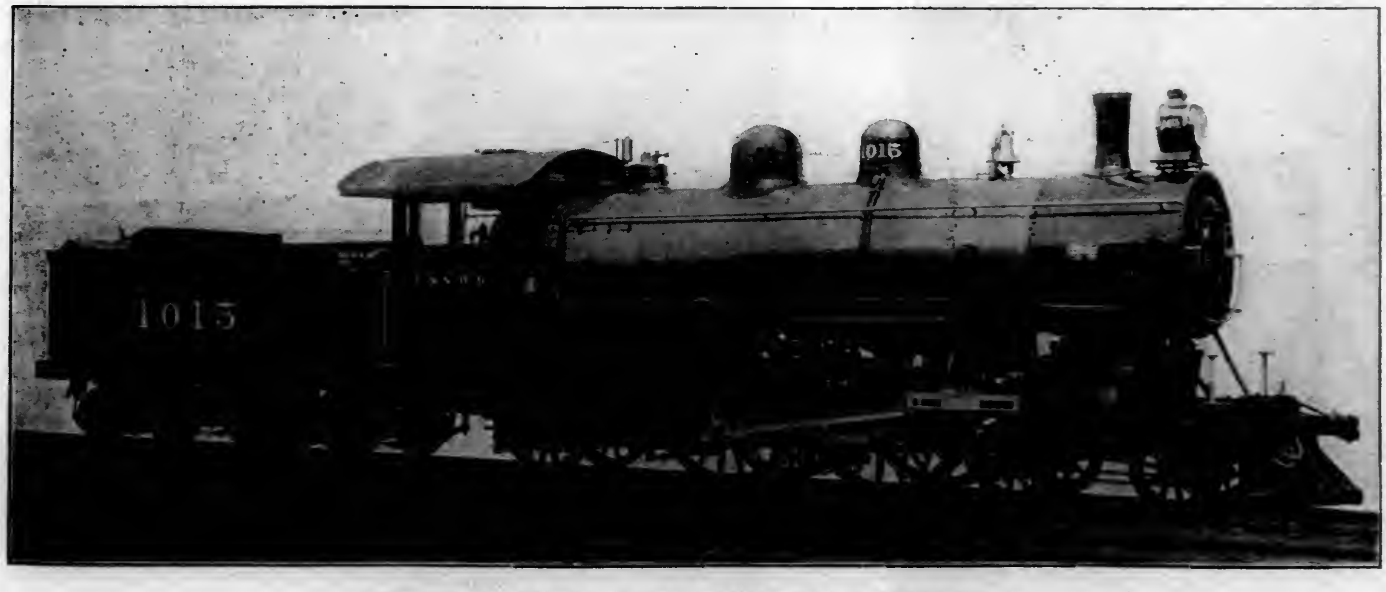
The chief departure from the usual Atlantic type is in the frame arrangement at the back end and the use of outside journals for the trailing wheels. Wider support for the firebox than can be had with the Atlantic type was desired. A wide firebox with the usual arrangement of frames causes considerable overhang of the mud ring at the sides, and with outside journals and supplemental frames the supports are placed directly under the mud ring at its extreme width. The purpose of this is to steady the engine and prevent excessive vibratory movements at high speeds. This design also simplifies the difficulties of getting in a good ashpan, and it removes the trailing journals from the heat of the ashes. The wide firebox is the special feature of this engine. It gives a large grate area without excessive length, and it may be increased in width if desired. In this respect the engine is capable of further growth and increase of power.

The valves are of the piston type with inside admission and the motion is direct. In every particular the engine represents great care in design and construction, and its influence upon future practice in fast passenger locomotives may be expected to be very strong in favor of larger grates. In fact we believe it to be the forerunner of a general introduction of wide grates for soft coal engines hauling heavy passenger trains. It is, therefore, considered one of the most important of recent American locomotives. Messrs. Quayle and Henderson, as well as the Schenectady Locomotive Works, are congratulated upon this production.

The following particulars have been furnished by the builders:

"North-Western" Type Locomotive.
General Dimensions.

Gauge	4 ft. 8½ in.
Fuel	Bituminous coal
Weight in working order	160,000 lbs.
Weight on drivers	90,000 lbs.
Wheel base, driving	7 ft. 0 in.
Wheel base, rigid	16 ft. 0 in.
Wheel base, total	26 ft. 9 in.
Wheel base, total of engine and tender	54 ft. 8¾ in.



"NORTHWESTERN" TYPE PASSENGER LOCOMOTIVE.

Chicago & Northwestern Railway. Schenectady Locomotive Works, *Builder*.

Weights: Total of engine..........160,000 lbs.; on drivers...... 90,000 lbs.; total, engine and tender, 20 ,000 lbs.
Wheel base: Driving...........7 ft.; total of engine........ 26 ft. 9 in; total, engine and tender............54 ft 8¾ in.
Cylinders: 20 x 26 in. Wheels: Driving ....80 in; truck...........36 in.; trailers........ 48 in.
Boiler: Straight, radial stays, diameter...... 68⅜ in; boiler pressure...... 200 lbs.
Firebox Length ....102⅛ in.; width ....65¼ in.; depth, front .... 76¼ in.; depth, back .. 67 in
Grate: Rocking; area............46.2 sq. ft.; Tubes 338 2-in .... 192 in. long.
Heating surface: Tubes..... 2,816.9 sq. ft.; water tubes............28.27; firebox............170.7; total ....3,015 sq. ft.
Tender: Eight-wheel; tank capacity............5,200 gals. water, 8 tons coal.

Cylinders.

Diameter of cylinders	20 in.
Stroke of piston	26 in.
Horizontal thickness of piston	5⅝ in.
Diameter of piston rod	3¼ in.
Size of steam ports	1⅝ in.
Size of exhaust ports	2¾ in.
Size of bridges	1⅞ in.

Valves.

Kind of valves	Piston
Greatest travel of slide valves	6 in.
Outside lap of slide valves	1¼ in.
Inside lap of slide valves	⅞ in.
Lead of valves in full gear	Line and line, 0 in.
Kind of valve stem packing	Hemp

Wheels, Etc.

Diameter of driving wheels outside of tire	80 in.
Material of driving wheel centers	Cast steel
Driving box material	Cast steel
Diameter and length of drivling journals	9 in. dia. by 12 in.
Diameter and length of main crank pin journals (main side 6¾ by 4½ in.)	6 in. dia. by 6 in.
Diameter and length of side rod crank pin journals	4½ in. dia. by 4 in.
Engine truck, kind	Four-wheel, swing bolster
Engine truck, journals	6 in. dia. by 10 in.
Diameter of engine truck wheels	36 in.
Kind of engine truck wheels	"National" steel tired

Boiler.

Style	Straight
Outside diameter of first ring	68⅜ in.
Working pressure	200 lbs.
Material of barrel and outside of firebox	Carbon steel
Thickness of plates in barrel and outside of firebox	11/16 in., ½ in., 7/16in.
Firebox, length	102⅛ in.
Firebox, width	76¼ in. F; 67 in. B.
Firebox, depth	76¼ in. F.
Firebox, material	Carbon steel
Firebox plates, thickness	sides ⅜ in., back ⅜ in., crown ¾ in., tube sheet ½ in.
Firebox, water space	front 4 to 5 in., sides 3½ to 5½ in., back 3½ to 4½ in.
Firebox, crown staying	Radial
Firebox, staybolts	Taylor iron
Tubes, material	Charcoal iron No. 12
Tubes, number of	338
Tubes, diameter	2 in.
Tubes, length over tube sheets	192 in.
Fire brick	Supported on 4 water tubes
Heating surface, tubes	2,816.91 sq. ft.
Heating surface, water tubes	28.27 sq. ft.
Heating surface, firebox	170.7 sq. ft.
Heating surface, total	3,015.88 sq. ft.
Grate surface	46.2 sq. ft.
Grate, style	Rocking, C. & N.-W. style
Ash pan, style	Sectional
Exhaust pipes	Single
Exhaust nozzles	4¾ in., 5 in., 5¼ in. dia.
Smoke stack, inside diameter	16½ in. at top, 14 in. near bottom
Smoke stack, top above rail	15 ft. 1⅝ in.
Boiler supplied by	Two Monitor injectors, size No. 10

Tender.

Weight, empty	43,200 lbs.
Wheels, number of	8
Wheels, diameter	36 in.
Journals, diameter and length	5 in. dia. by 9 in.
Wheel base	16 ft. 10 in.
Tender frame	10-in. steel channels
Tender trucks	4-wheel, channel iron, center bearing and side bearings on both trucks
Water capacity	5,200 U. S. gallons
Coal capacity	8 tons

THE CONSULTING ENGINEER AND SHOP PLANS.

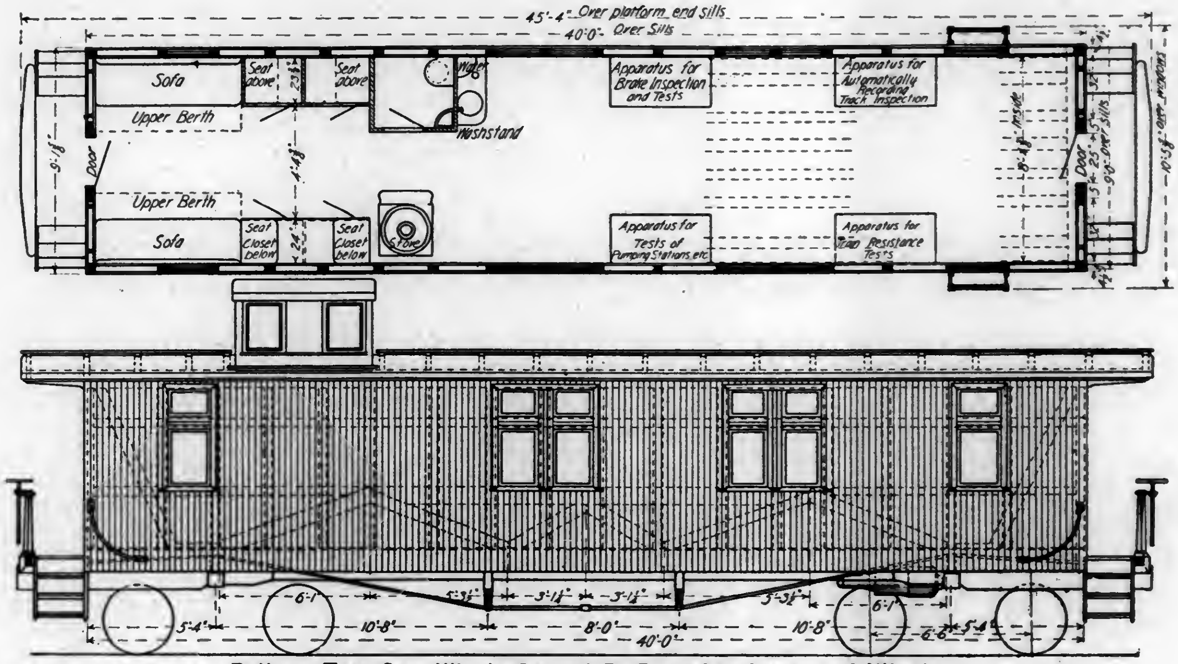
In summing up the progress which has been made during the past ten years in various branches of railroad work, that of shop arrangement and equipment has not had its share of attention. A great deal has been achieved in shop improvement and the electric motor seems destined to work still more changes, not only in arrangement of buildings and machinery, but even in the matter of location of shops. A few years ago motive power department draftsmen were able to plan and carry out extensive shop improvements. The problems were comparatively simple before it became necessary to decide upon the methods of power distribution, the capacities of generators with reference to those of the motors, the most favorable selection of units for individual and for group driving, the sizes of groups, the determination of voltage and the systems of wiring. Now also the gas engine and steam turbine come in for attention in the power-house question. These questions and those of shop heating, ventilation and lighting may all be settled indifferently well by consultation with those who are prepared to contract for the complete equipments of the various kinds, but there is a better, a more satisfactory and almost necessary method, entrusting all of the plans and details to a specialist, a consulting engineeer who has the necessary experience and information and can bring to bear a knowledge which no one else may hope to possess. The tendency to employ a consulting engineer for the plans of new shops is a marked step in advance which should be recognized. There are three good reasons why he should be called upon. The mechanical officers are now overloaded, and while they are always ready to do this work, something else must suffer if the new shops receive the attention they require. The questions call for a wider special kind of experience than the motive power man can be expected to have, and last and most important, the right kind of consulting engineers for this work are now available. Railroad managements will do well to take these facts into consideration in connection with new shops. It is not necessarily the best arrangement from a steam engineering standpoint that will give the best results, but rather a balance of a large number of very peculiar factors and the fact that they will affect the cost of the repairs of rolling stock for many years should lead to the right view in regard to the engineer's fee.

BETTER "FOOTPLATES" ARE NEEDED.

Methods for fastening the rear ends of locomotive frames need more attention as the capacities of locomotives increase. The old-time, heavy cast-iron footplate is now seriously missed as a factor in holding the frames against the tugging action caused by the sudden application of high pressure against large pistons. As soon as a little motion is produced between these parts looseness and wear begin, and then frames and cylinders begin to break and saddles loosen from the smokebox. The back ends of the frames need to be more rigidly secured than ever before. The single or double bars across the frames at the ends with a gained joint are insufficient in stiffening capacity, and they are often put together with a joint which is almost impossible to fit with accuracy when built and is sure to work loose in service. When once loosened the stresses which should be met here are transferred to some other point. The part which now takes the place of the footplate should have ample bearing surfaces and plenty of bolts. It should be made with a view of securing a tight, firm fit, and whether bolted or riveted, precautions should be taken to avoid the shocks of pulling and buffing. A good way to accomplish this is to provide a spring buffer between the engine and tender which will keep the tender draft link always in tension. If the slack of this link is always taken up the whole frame system of the engine will be relieved from a lot of destructive stresses. It may at first appear impossible that excessive lead of the valves should exert an influence upon the rear frame connections, but it has recently developed that this is the case. It should be remembered that steam pressures have been rising as weights have increased, and excessive lead with 200 or 225 lbs. boiler pressure subjects the whole engine to a series of violent shocks. Framing and bracing must be strong to resist them. These facts are brought to mind upon seeing heavy engines built, as they are now being built, with only two relatively small wrought-iron braces across the back ends of the frames. This is not believed to be a good way to save weight.

Scale is generally removed from boiler flues by "rattling" them in a tumbling barrel or by machines to cut through the deposit and grind it off. An improved and very convenient method used at the Sayre shops of the Lehigh Valley is recorded by the "Railroad Gazette." The flues are heated to a cherry red in a long furnace and then dropped into cold water. The difference in the contraction of the tube and the scale causes the scale to crack off and leave the tubes. It is found to be cheaper than the other methods at Sayre.

Professor W. F. M. Goss has been chosen Dean of the engineering schools of Purdue University, a merited honor upon which we join his numerous friends in congratulations.



Railway Test Car, Illinois Central R. R. and University of Illinois.
Fig. 1.—Side View and Plan.

Fig. 2.—End View.

TEST CAR OF THE ILLINOIS CENTRAL RAILROAD AND THE RAILWAY MECHANICAL ENGINEERING DEPARTMENT OF THE UNIVERSITY OF ILLINOIS.

By Edward C. Schmidt,

Instructor in Railway Mechanical Engineering.

This car is now almost completed at the Burnside shops of the Illinois Central Railroad at Chicago. It will be owned and operated jointly by the Illinois Central Railroad and the Railway Mechanical Engineering Department of the University of Illinois, the car being built by the former and the apparatus and other equipment by the latter. It is designed for general railroad experimental work and will be adapted for the following purposes, for each of which it has its special equipment: Measurement of train resistance; autographic track inspection, locomotive road tests and air brake tests.

Hydraulic transmission of the pressure and motion has been adopted for the apparatus for dynamometric work and for track inspection; the latter, however, is not being at present installed. The car has been designed under the direction of Mr. Wm. Renshaw, Superintendent of Machinery, Illinois Central Railroad; Professor L. P. Breckenridge of the Department of Mechanical Engineering of the University of Illinois, and the writer. The car itself has been specially designed for this work and is shown in Figs. 1 and 2. It has been made particularly heavy, in order to withstand the usage it will receive in the heaviest freight service.

It is 45 ft. 4 in. in length and 40 ft. over the end sills, which is as long as is compatible with the necessary stiffness and rigidity. It is 8 ft. 4⅜ in. wide inside, 9 ft. 1⅝ in. outside, with an extreme width of 10½ ft. over the observation windows. About 15 ft. in the rear end is occupied by the berths, lockers, closets and toilet-room, leaving 25 ft. working space in which are placed the tables and instruments. The lookout shown in the rear of the car affords facilities for observing the handling of the train, and in it are placed the push-buttons controlling the signals to the operators below, and also the pens which mark on the dynamometer record the location of mile posts, stations, curves and grades. The projecting windows at the front end also provide means for watching the train and engine. The next three figures show the general arrangement and some of the details of the apparatus used in experiments for the measurement of train resistance, which constitutes at present the more important part of the equipment, the track inspection apparatus not being designed as yet. Fig. 3 is a diagram showing the various parts of the apparatus in their relations to one another. The pressure due to the pull on the draw-bar is taken in a cylinder filled with oil, and this pressure transmitted by the oil to the recording and indicating gauges in the car above. The record of the amount of draw-bar pull is made on a continuous strip of paper 6 in. wide, which is drawn past the marking pen on the recorder at the rate or 13.2 in. per mile.

The paper is driven from the car axle as indicated and upon

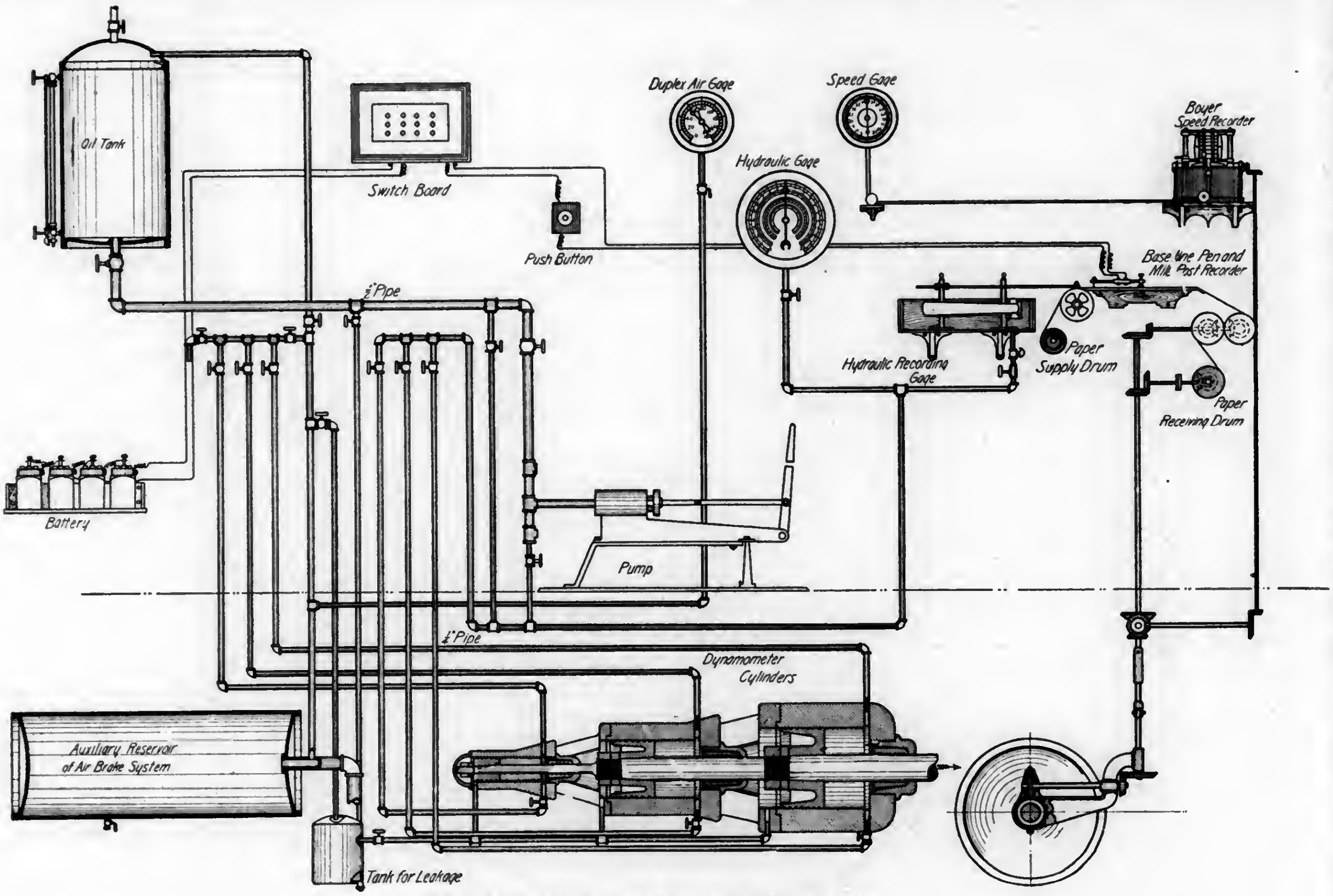


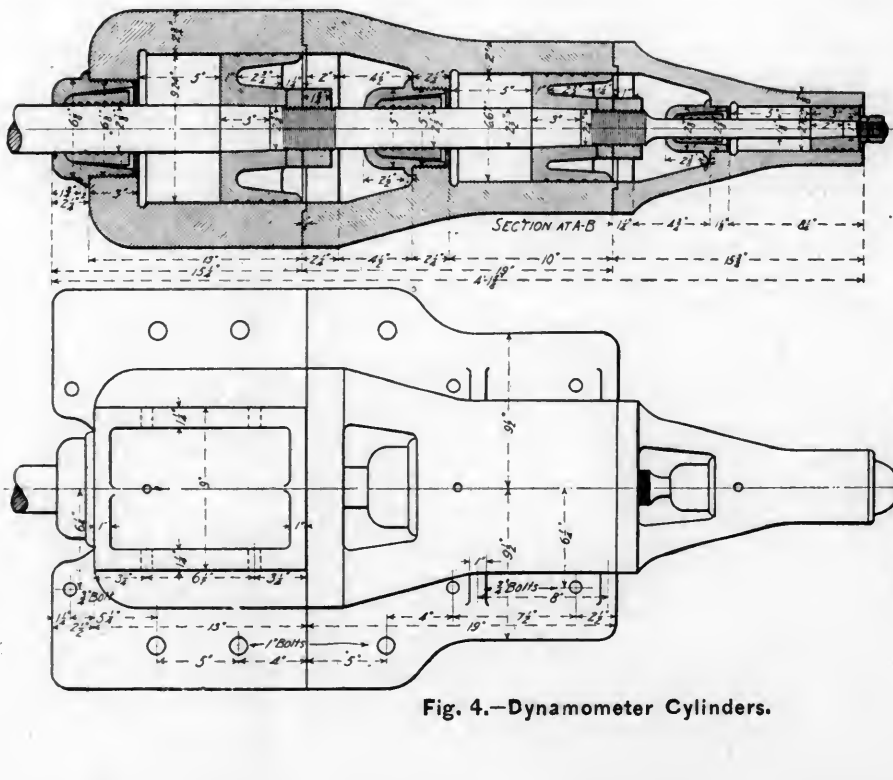
Fig. 3.—General Arrangement of Apparatus.

it are marked, in addition to the curve showing the pull on the draw-bar, the location of mile posts and stations, and also time. The mile post pen, which is controlled by electro-magnets, draws a continuous line and at mile posts and stations is drawn slightly aside by these magnets, which are operated from a push-button touched by the observer in the lookout. The pen recording time is similarly made and is automatically controlled by a clock which makes electric contacts every five or ten seconds as desired. A speed record is also obtained upon a separate chart in the speed recorder shown at the right.

The oil pump receives its supply from the oil supply tank, and by properly arranged piping forces it into the three cylinders of the dynamometer. Compressed air, taken from the auxiliary reservoir of the air-brake system, is used to clear the oil from the cylinders when necessary, and also to aid in filling them and to blow back from the leakage tank whatever oil leaks by the pistons and stuffing-boxes of the three cylinders.

From the switchboard electric connections are made to the various signals and pens, to the revolution counter in the car which shows the revolution of the driving wheels and also to the electric signals for indicator cards at the front end of the engine.

The dynamometer cylinders are shown in Fig. 4. They are made in three castings held together by stud bolts, not shown in the



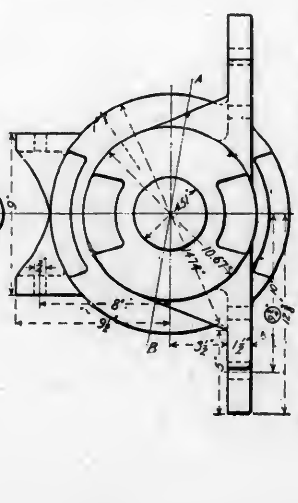
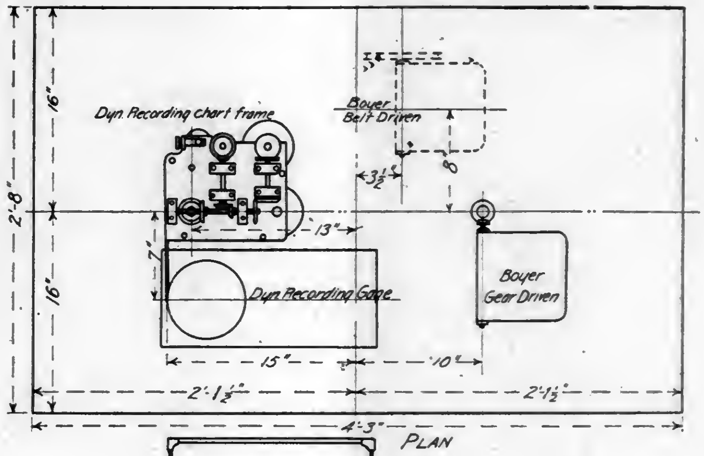


Fig. 4.—Dynamometer Cylinders.

drawing. The effective area of the largest cylinder is 60 sq. in., of the second 30 sq. in., and of the smallest 5 sq. in. It is intended that the working pressure of the oil in the cylinders is to be from 300 lbs. per square inch to 1,000 lbs. per square inch, and for this range of pressures cylinder No. 1 has sufficient capacity for the heaviest freight service, No. 2 will be used when working with a train of ordinary tonnage, while No. 3 will be used for passenger service. In this last case the working pressure may be somewhat higher. If it should become necessary, cylinders 1 and 2 could be coupled up in tandem, thus giving an effective piston area of 90 sq. in.



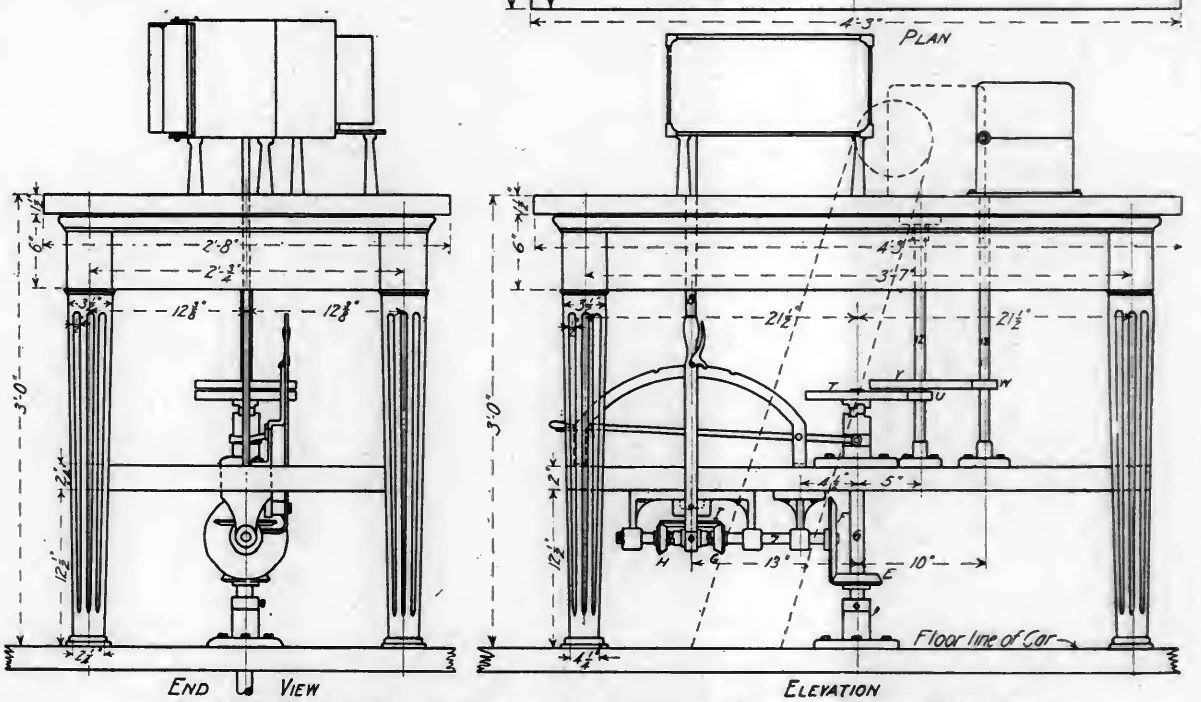


Fig. 5.—Table and Plan of Dynamometer, Recording Gauge and Speed Recorder.

The piston rod is connected to a draw-bar yoke of special design and is so arranged that when the piston travels forward too far beyond its working position the pull is taken on the springs of the ordinary draw-bar rig. Pushes on the rod are likewise received immediately upon these springs. An electric "tell-tale" arrangement notifies the operator when the piston passes its proper limits on account of the leakage of oil. The cylinders are reamed, the pistons ground and the piston rod ground where it moves through the stuffing-boxes. The stuffing-boxes were designed particularly for this arrangement and consist essentially of the inner sleeve or gland, which is ground internally to fit the rod and grooved as shown to retard the leakage. The forward end of the gland is ground spherical and fits into a ground spherical seat in the stuffing-box casting. This spherical seat is used to permit the three sleeves to align themselves properly on the rod. The pressure of the oil keeps the gland on its seat and the oil pressure is supplemented by the pressure of several helical springs placed between the rear end of the sleeve and the plate shown at the inner end of the stuffing-box. Considerable difficulty was experienced in making the joints between the cylinders and pistons and between the stuffing-boxes and rods sufficiently good to prevent undue leakage; but this has now been accomplished and the leakage under the upper limit of the working pressure, i.e., 1,000 or 1,200 lbs. per square inch, is not sufficient to in any way interfere with the proper working of the apparatus. The pistons will move forward on account of the leakage; but so slowly that the cylinders can be refilled from the pump at stops, or if necessary when the cylinders are under pressure. This design was resorted to in order to avoid the uncertainty concerning the frictional resistances incident upon the use of the usual packed pistons and stuffing-boxes.

The cylinders have been calibrated, in connection with their gauges, upon an Olsen testing machine, and the total pull on the rod necessary to overcome the friction in the apparatus found to be about 30 lbs. The cylinders are secured to the draught timbers by means of the flanges shown at the sides and top.

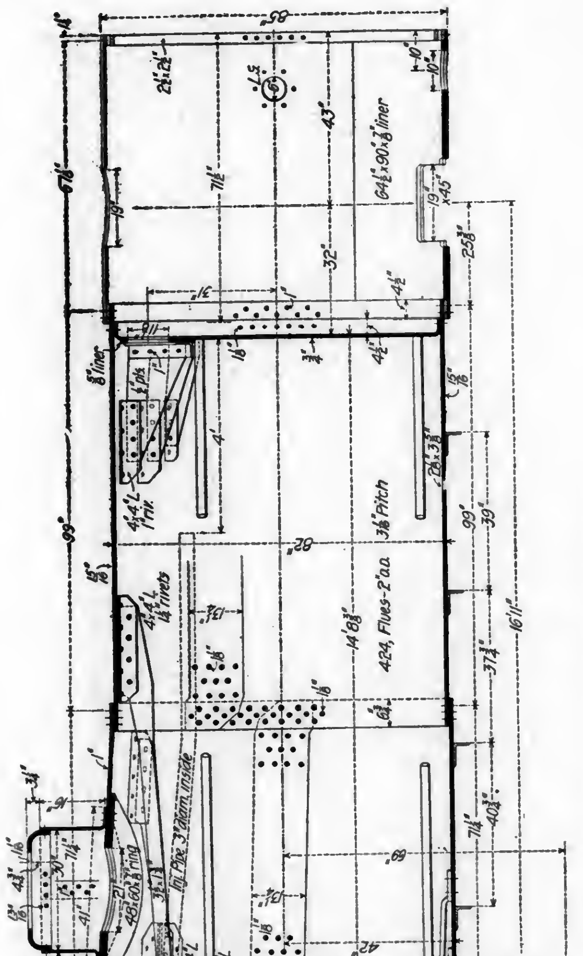
In Fig. 5 is shown the table upon which are placed the dynamometer recording gauge, the rolls for driving the paper chart, and the Boyer speed gauge. The vertical shaft projecting through the floor under the middle of the table derives its motion from the car axle by means of spiral gears and bevel gears. Its motion is transmitted, by means of the gears shown, to the speed gauge and to the paper driving apparatus. This last consists simply of a pair of driving rollers, around which the paper passes, and a supply roller and receiving roller. The paper is drawn from the former and fed to the latter after running over the drum of the recording gauge seen also at the left.

In addition to this apparatus the car is equipped, for locomotive road tests, with gauges for indicating and recording boiler pressure and steam-chest pressure, duplex air gauge, air brake train line pressure recording gauge, and the other apparatus used in locomotive tests. The track inspection apparatus and other apparatus are to be installed later.

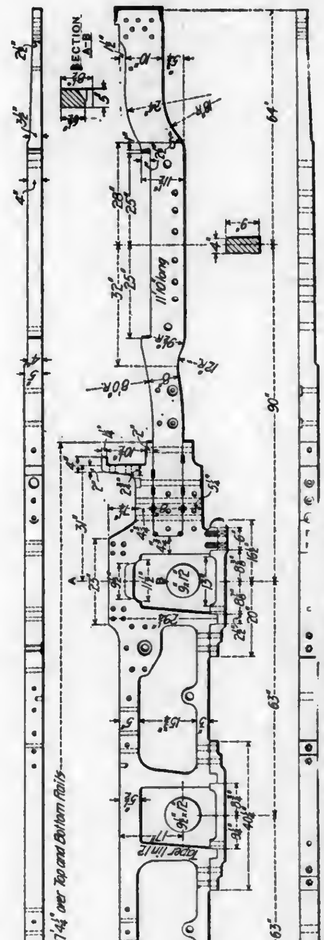
BOILER AND FRAMES—TWELVE-WHEEL FREIGHT LOCOMOTIVE.

Illinois Central R. R.

Built by the Brooks Locomotive Works.



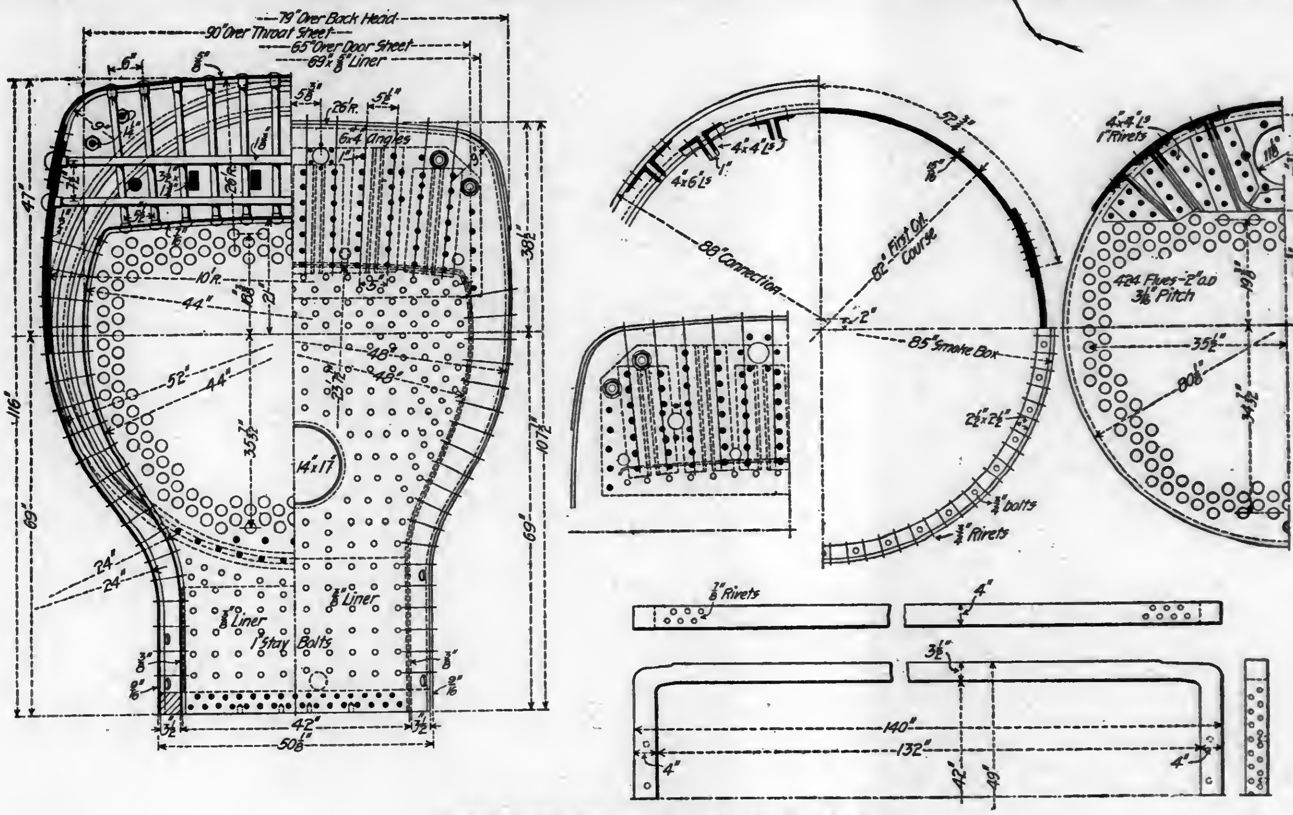
Twelve-Wheel Freight Locomotive—Illinois Central Railroad. Longitudinal Section of Boiler.



Twelve-Wheel Freight Locomotive—Illinois Central Railroad. Views of Frames Showing Single Bar Front Section.

The largest locomotive boiler ever built* seems worthy of illustration on account of its size if it was not otherwise interesting. The locomotive built for the Illinois Central by the Brooks Locomotive Works was illustrated in October, 1899, page 315, and we now show the boiler and frames. Attention has already been called to the high boiler pressure, 210 lbs., and the thickness of the sheets. The boiler is 82 inches in diameter at the front end and 85 inches over the smokebox. It is 90 inches wide at the firebox. The boiler is the "Player Improved Belpaire" type. The heating surface is 3,500 square feet and the grate area 37.5 square feet. The heating surface is large but it has been exceeded. The grate area is very large for a narrow firebox engine, the length being 11 feet. The boiler is very high above the rails, the center being 9 ft. 8 in. above the rail tops. This is the highest of which we have record, the Great Northern 12-wheel engines, at 9 ft. 5 in., being the highest previously built. This boiler is riveted with lap seams, a form which these builders appear to favor. There are 424 2-inch tubes, 14 ft. 8 in. long, placed at 3 1/16 inch pitch; the drawings clearly show the staying and bracing, the arrangement of the seams and other details to which special attention need not be called. This boiler was designed with a view of pulling a train weighing 2,045 tons, exclusive of engine, tender and caboose, up a 38-foot grade, combined with uncompensated curves of 3 degrees, at a speed of 15 miles per hour. To do this it will be necessary for the boiler to furnish steam enough to maintain a mean effective pressure of about 175 pounds.

*Since this article was written a much larger boiler, that of the Pittsburgh engine for the Pittsburgh, Bessemer & Lake Erie, has appeared. See American Engineer, July, 1900, page 214.



Transverse Section of Boiler and Firebox.

The frames are heavy and strong. The front end is the interesting feature. This form has been used by these builders for all engines with piston valves since the completion of the 12-wheel engines for the Great Northern (January 1898, page 3). The Great Northern engine had double bar frames, but since that time the single form has been used and with this bar of 4 by 9 inches section at the cylinders the construction is strong and stiff. It is probably better than the double frame of the Great Northern, and infinitely better than the ordinary single bar frame. In this design the center line of stress coincides approximately with the center line of the frame. This is important in heavy locomotives, and especially so in those with four-wheel trucks, giving a long distance between the cylinder and the splice and to the forward driving axle. In the double frame construction it is impossible to balance the stresses in the upper and lower members. The single bar frame in this case was not used to get out of the way of the piston valves, but the entire front end arrangements were planned to secure better construction, which should be strong and stiff.

It will be noticed that the front ends of the upper bars of the double portions of the frames are turned up to form knees for the attachment of the guide yokes. This is done on all piston valve engines with single bar front frames, and on slide valve engines with four-wheel trucks a similar bracket is forged upon the upper section of the forward rail. The guide yoke is lugged over the frame lugs and securely keyed against the frame in a manner similar to that with which the frames are keyed to the cylinders, thus forming a double lock. A double brace of hammered iron extends across the frames at the forward drivers. It carries the transverse equalizing spring, and the boiler brace is attached to it. A cast steel brace extends across the frames in front of the throat sheet and makes the expansion connection between the boiler and frames in front of the firebox.

The new torpedo boat "Viper" of the British Navy made a new speed record July 13 of 43 miles per hour. Our readers will remember that this boat is driven by Parsons steam turbines. The speed is remarkable, and is very close to that of long-distance railroad trains. Absence of vibration and small space per horse-power, with excellent steam economy, are the features which render the steam turbine specially desirable for such service.

The lease of the Fitchburg Railroad to the Boston & Maine has at last been accomplished. Changes will probably be made in the operating departments, but what will be done has not yet been announced. This move places the valuable terminal facilities on the north side of Boston under a single management, and it seems likely to result profitably to the stockholders of both roads, particularly if the prospective lease of the Boston & Albany to the New York Central is carried through. The necessary legislative action has been taken since the above was written, and the New York Central now reaches Boston.

The Wheeling & Lake Erie are planning extensive improvements in their shops at Ironville, a suburb of Toledo. The old paint shop will be replaced by a new building 100 by 300 ft., which will be used as an erecting shop, and the old erecting shop will be used as a paint shop. A new machine shop, blacksmith's shop and store room will be put up. The plans are being prepared by Mr. Charles Hazen, Master Car Builder, under the direction of Mr. Braden, Superintendent of Motive Power of the road. The shops will be equipped with new tools. At present the road is turning out eight new high-sided coal cars per day on an order for 1,200.

In many ways the "Daily Railway Age" at Saratoga this year is a worthy example among newspapers. It is a unique production in conception, purpose and conduct. For years the members of the Association have found it convenient and valuable as a prompt and extensive record of the proceedings of the conventions. It is more than a daily record of the discussions, for, until the appearance of the official volumes, it is the most complete account available, and to members who are prevented from attending it must be invaluable. Railroad men and supply men alike commended it especially this year and it is evident that the enterprise of the management is appreciated. This is indicated by the demand for the papers as they came from the press and by the unusual amount of advertising this year.

PROBLEMS THE WIDE FIREBOX SOLVES.

From the Fireman's Point of View.

By J. S. S. Fulton.

A study of how the demands of modern transportation and continued high speed with heavy trains have been met by the Motive Power Department shows very little departure from the old, and one may say the locomotive has simply grown in size to meet these demands. But that the firebox of the modern locomotive has reached the limits permissible under structural and operative conditions, must be conceded. Carefully considering the changes of conditions that time has brought about, and tracing the failures for steam with impartiality to find the direct cause, we perceive that the steam demand has grown beyond the limit of the firebox.

For the past several years I have kept a careful record of the failures for steam by the engines of the division to which I was assigned. For 78 per cent. of the failures the following causes are given by the engineer and fireman: "Poor coal," "fire getting too dirty," "had to stop to clean fire." These failures were reported on runs of an average of 150 miles, many of which made no stop. These failures are both undesirable and costly, and by an application of the proper natural remedy —grate surface—can be avoided.

The writer served eight years as a fireman on four of the largest railroad systems, including four years with the wide firebox in every class of service, from a switcher to the "flyers" on the Atlantic City R. R., with both anthracite and bituminous coal. And from the investigation and study which the ideal opportunity for comparison afforded me, I attained by practical experience and experiment a conviction of the merits of the wide firebox that cannot fail to assert themselves, when the awakening to this fact becomes complete, which a reference to the railroad journals tells us has begun. The prejudice of the railroad men to anything new or different from the old "rut," coupled with the lack of the proper instruction that usually fails to accompany any radical departure from the usual practice and the unhandiness that comes with anything different from what one has long been accustomed to, should caution every Superintendent of Motive Power to prepare for a "howl" when he introduces his first wide firebox. We all remember the introduction of the injector and the improved air brake. Neither can he expect the anticipated results for some time, unless he procures the services of some competent wide firebox fireman or engineer for a short time as instructor.

While I was firing an Atlantic type engine on the Atlantic City R. R., where a speed is attained and maintained that is not possible with the narrow firebox (not considering that the trains drawn consist of from 7 to 13 cars), a delegation of engineers and firemen from some Western road, who were East on a pleasure trip, came up to the engine as we were lying in the depot at Camden waiting for the leaving time for Atlantic City, 56.6 miles distant. After commenting humorously on the queer appearance these engines present to the beholder for the first time, one old gray-haired engineer remarked with emphasis, "I wouldn't run such a looking machine"; and several of the firemen seconded it by saying, "And I wouldn't fire one." But when we stopped in Atlantic City depot just 49 minutes and 40 seconds after we got the starting whistle, and while some of them had watched from the window in the door of the first coach with what little effort and work it was done, there were different kinds of expressions and a desire to know more of the wonderful machine. But the whole story was a short one—Grate Surface.

Returning to my engine failures. By investigating I found that nine times out of ten, good, and in most cases the best coal had been ordered and paid for; but in consequence of the short-sighted system of buying coal employed by most railroad companies the coal companies can practice the most unjust imposition. It is expensive to buy good coal; it is still more expensive to pay for good and get poor coal. A better way would be to buy poor coal and design fireboxes to burn it. I have seen and fired bituminous coal of so bad quality that it was known among the men as "asbestos sand," and yet have made all the steam required for the heavy fast freight service on the Philadelphia & Reading R. R. between Allentown and Harrisburg; and when the same fuel was put on a narrow firebox engine, as an experiment, we could barely "crawl" to the first coaling station.

A wide firebox will run about twice as far as a narrow one without cleaning; and does not require the fire to be "built up" and "burnt through" before starting as is necessary with the narrow type. Fire enough to cover the grates when spread just before leaving is sufficient. (This is no small saving to begin with.) These facts alone lead to the conclusion that the narrow firebox has already outlived its usefulness and is at best a make-shift out of date.

The lack of a good design that will bring the engineer and fireman together has been beyond doubt the greatest factor in preventing its adoption; although the "Prairie Type" goes a great way toward securing sufficient grate area and solving this. Any design that isolates the engineer from the fireman will never live as a standard. The death of the engineer without the knowledge of the fireman is not the only thing to be feared; sleep comes much oftener during the natural life of a man than death; and although I have never fired an Atlantic type engine with an engineer a corpse at the throttle, yet I have gone many miles, many times, with one asleep there, and my experience leads me to doubt if they are any better than corpses.

Although the best amount of grate area is perhaps undetermined, the writer conducted a series of experiments with bituminous coal on a 19 x 24-in. cylinder engine with a wide firebox of 76 sq. ft. grate surface and a 4¾-in. single exhaust nozzle. Thirty-six square feet of the front portion was bricked off by covering the grates with fire-brick; after each trip a row of brick was removed, and the exhaust nozzle enlarged until all the bricks were removed and the nozzle enlarged to 5 7/16 ins. with a decrease of fuel consumed each trip until 60 sq ft. were uncovered, after which no perceptible decrease could be noticed. There was a notable improvement in the smartness of the engine as the nozzle was enlarged and almost entire absence of smoke. Another test showed very little difference between the ratio of a poor grade of coal in a wide firebox and a good grade in a narrow one, proving that there is an avenue of waste in the narrow box, either from imperfect combustion or from the amount of fine coal that passes unconsumed through the flues, or both.

But there are still other problems the wide firebox solves. Good fuel cannot always be had, especially in mid-winter (when it is needed most) and when the demand for good grades is heavy and the price high. The extreme exertion required to fire the long narrow boxes that are designed on modern large locomotives has led to a serious agitation and on some roads an actual demand for two firemen on an engine. The wide firebox will stave this off for a long time to come, as the work is very much easier. Firemen on the Philadelphia & Reading R. R. say it is like taking a day off to fire one of the Wootten boilers after firing the narrow ones. The smoke nuisance is giving more and more trouble every day, and of all the smoke-burning devices and smokeless firemen I have yet met, none will approach the solution of this great problem nearer than a Wootten boiler properly fired.

As Mr. Edward Grafstrom's suggestion in the May issue of this magazine is open for criticism I venture to say that his proposed arrangement of ashpan over back drivers will burn out grates faster than they could be cast. The writer has had some experience along that same line. But if it were not for this objection it embraces more desirable features than any design yet produced.

COMPARISON OF HIGH-SPEED TRAINS.

A novel and interesting comparison of high-speed trains has been compiled by Mr. T. A. Lawes, Superintendent of Motive Power of the Chicago & Eastern Illinois Railroad, which is reproduced in the accompanying table. The Chicago, Rock Island & Pacific and the Chicago & Northwestern show the highest tonnage per square foot of grate and of heating surface. The Lehigh valley train, however, is probably hauled at fully as great advantage as the others in expense per ton mile. Such a comparison is new to us, and it is suggestive of the wide differences in locomotive practice in different parts of the country. The table is as follows:

COMPARATIVE HIGH SPEED TRAINS.

Name of R.R.	From–To.	Distance in miles.	No. of cars in train.	Weight of cars in tons.	No. station stops.	Miles run to one stop.	Schedule running time. H. M.	Average speed in miles per hour.	Style of engine.	Size of cylinder. In.	Diameter driving wheel. In.	Grate area, sq. ft.	Total sq. ft. heating surface.	Boiler pressure in lbs.	Tractive power at 85% of boiler pressure.	Ton miles per hour per sq. ft. of grate area.	Ton miles per hour per sq. ft. of heating surface.
N. Y. C. & H. R.	New York Albany.	143	4	190	none.	......	2 40	53.7	8 Wh.	19 x 24	78	31.2	1,974.0	180	17,000	327.0	5.1
C. B. & Q.	Chicago Burlington.	206	4	200	2	103	3 52	53 3	Columbia.	18 x 26	84	31.8	1,599.5	200	17,045	335.2	6.6
B. & O.	Baltimore Washington.	40	7	240	none.	......	45	53.3	10 Wh.	2 x 26	78	34.3	2,155.1	190	23,740	372.9	5.9
Wabash	Tilton Granite City.	176.6	7	302	8	22	3 36	49.0	Atlantic.	19 x 26	73	29.8	2,423.2	200	21,860	496.2	6.1
Lehigh Valley	Buffalo Jersey City.	446.6	7	226.75	11	40.6	9 31	46.9	10 Wh.	19 x 26	70	63.9	2,200.0	180	20,510	166.4	4.83
C. & N. W.	Clinton Chicago.	138	9	470	6	23	3	46.0	8 Wh.	19½ x 26	68	30.4	2,504.2	190	23,495	711.1	8.63
C. R. I. & P.	Engewood Rock Island.	174	10	404	14	12.4	3 51	45.2	8 Wh.	19½ x 26	78	24.5	1,988.3	190	20,482	745.3	9.18
C. C. C. & St. L.	St. Louis Indianapolis.	273	8	340	9	30.3	6 5	44.8	8 Wh.	20 x 26	78	31.0	2,162.0	200	22,665	491.3	7.04
C. & E. I.	Dolton Jct. Danville Jct.	106.5	5	190	8	13.3	2 25	44.1	8 Wh. 8 Wh. Mogul.	18 x 24 18 x 24 18 x 24	66 66 63	16.3 24.3 26.1	1,393.4 1,397.4 1,482.3	170 180 180	17,020 18,020 18,880	514.0 344.8 319.8	6.01 5.9 5.65
L. S. & M. S.	Chicago Buffalo.	535	8	335	14	38.2	12 53	41.8	10 Wh.	18 x 24	68	27.35	1,866.0	190	18,465	511.9	7.5
Atlantic Coast Line	Richmond Charleston.	396	5	225	2	198	9 46	40.5	Atlantic.	19 x 24	72	26.1	2,047.2	180	18,410	345.3	4.4
Grand Trunk.	Port Huron Blue Isl'd Jct.	315.5	9	300	15	20	7 55	40.4	10 Wh.	20 x 26	72	33.3	2,001.0	200	24,550	363.9	46.05
Great Northern	Minneapolis Barnesville.	210	11	not given.	8	26.2	5 20	39.4	10 Wh.	19 x 26	73	24.6	1,797.0	180	19,670	....	....
M. C.	Detroit Kensington.	271	8	262	9	30.1	7 10	37.7	10 Wh.	19 x 24	62	28.5	1,703.8	160	19,000	346.5	5.79
Northern Pacific	Northtown J. Fargo.	229.2	8	330	6	38.2	6 15	37.2	10 Wh.	20 x 26	69	30.8	2,485.0	200	25,620	398.5	4.9
Ill. Central.	Fulton Memphis.	121	10	395	5	24.2	3 30	34.5	10 Wh.	19½ x 26	69	28.0	2,031.7	200	24,416	486.6	6.7

THE MODERN ROUNDHOUSE—WHAT IT OUGHT TO BE.

The business advantage of the maximum possible mileage of locomotives has been sought during the recent season of extraordinary traffic in order to make the most of the available power, and whether or not pooling of locomotives has been accepted as the best way of accomplishing this result, all are endeavoring to secure large mileage. An effect of this, which is probably to be permanent, is to show the weakness of present roundhouse practice. Roundhouse repairs become more important with the increase in size of engines, and the expense of running repairs aggregates "almost as much per 1,000 miles run as do the shop repairs." This fact and the necessity for "turning engines" quickly give to roundhouse work an importance which it never had before. Because of its thorough treatment of the subject and its suggestiveness, the attention of our readers is directed to the following recent report on the equipment and arrangement of roundhouses by Messrs. W. H. Marshall, George W. West and C. H. Potts to the Central Railway Club:

Modern locomotives have outgrown the dimensions of old houses and even recent houses are not, in all cases, made large enough to accommodate modern power. The up-to-date house should be at least 80 ft. between inside walls. As modern engines will approximate 65 ft. in length, this will leave only 15 ft. to be divided into spaces, which will permit workmen to pass around both ends of the engine, and to truck materials when necessary. The outer wall should be of brick with ample window area in it, and the inner wall should consist of cast-iron columns, spaced about 13 ft. centers with rectangular door openings and with plenty of glass in and above the doors. The rectangular doorway is better than the arched one, as it permits a hinge to be placed near the top of the door, which is of value in preventing the door from getting out of shape and racking to pieces.

The roof trusses should be of wood, as iron is corroded rapidly by gases present in the house. The best form is the common shed roof with a moderate slope, the greater height being on the inside walls.

The engines, when standing in the house, should face the outer wall; the chief reason being that there is more room and better light between engines at the machinery, where most of the work is required, than would be the case if the engines faced the table. To those that desire clean engines, there is an incidental advantage in that the engines, when starting out of the house, back on to the table, thus throwing less of the dirt from the stack over the engine.

The turntable should be a substantial affair, and a length of at least 70 ft. is to be preferred. It should be operated by electricity, if the current is obtainable at a reasonable cost. A compressed air engine is a good substitute when electricity is not available.

There is such a wide divergence of opinion regarding the roundhouse floors that we hesitate to indorse any one construction without qualification, but we believe that something better than a dirt floor is required for what might be called the work section of the house, where boiler washing and the heavier machinery jobs are done. Vitrified brick would appear well adapted to this section of the house. Whatever material is used for the floors, there should be planks suitable for jacking upon placed immediately outside of the rails.

All the steam, water and air pipes should be placed overhead, nothing going underground except the sewers. The main sewer should, if possible, be outside the outer walls and all pits, including the turntable, drained into it. The overhead pipes should include the water pipes for boiler washings and filling boilers, also an air pipe for kindling fires and a steam pipe for the blowers. There should also be placed overhead a pipe of not less than 4 in. in diameter, with suitable connections at

each stall, so that engines may be blown off in the house and the escaping steam discharged through this pipe. Such an arrangement will not only do much toward keeping the house free from steam in winter, but it will also prevent, to a large extent, the injury to boiler jackets due to drippings from the underside of the roof. Furthermore, the constant presence of steam throughout the house causes a rapid deterioration of the house itself.

The house should be lighted with electricity, if it is available. Economy demands better light than we find in most roundhouses. The turntable and the coal chutes should also be lighted by electricity.

The customary method of heating roundhouses is to use live or exhaust steam, circulating in pipes placed on the two side walls of each pit. The ventilation is supposed to be accomplished by ventilators of various kinds, placed on the roofs. While some of these utilize the outside air currents to draw the foul air and gases out of the house, they must all depend upon natural draft when the outside atmosphere is quiet. At such times the ventilation is practically nil. We believe that the hot blast system of heating is not only an improvement over the heating apparatus now commonly used, but will solve the entire question of ventilation in winter. With a large volume of warm air being forced into the house, the gases and steam will be driven out of the ventilators. Thus it is possible to have a roundhouse that, with windows and doors closed, is nevertheless a comfortable place to work in. In summer the open doors and windows take care of the ventilation. In using the hot blast system the air should be delivered through ducts which terminate in the side walls of each pit, thus delivering the air where it will be most effective in thawing out engines that have come into the house covered with snow and ice.

The general equipment of a roundhouse should comprise such machinery, small tools and stock of supplies as will permit all running repairs to be made with dispatch; the line should be rigidly drawn, however, between roundhouse repairs and work that properly belongs to the shop, and the roundhouse forces should not be allowed to undertake extensive repairs upon an engine, except in rare emergencies. There is a disposition on the part of some roundhouse foreman to keep at least one engine under repairs at the roundhouse, so that when the regular work becomes light the men can be switched onto this job; it invariably results in holding the engine undergoing the repairs many times as long as would be required if the work had been done in the shop, and furthermore the expense of such repairs will be higher than it should be. But while thus excluding the shop work from the roundhouse, we believe there should be a sufficient equipment of tools at every large roundhouse, so that the running repairs can be handled quickly. Such tools as are installed should be first-class in every respect and should not be old-fashioned, worn-out tools discarded by the shops. Modern tools should be provided even if it is necessary to purchase new ones in order to accomplish it.

The equipment should consist of not less than one 14-in. lathe, one 26-in. lathe (or larger), one 30-in. drill press, one bench drill, one 1½-in. single-headed bolt cutter and one 26-in. shaper (planer movement), and one 30 by 30-in. planer. These tools, if supplemented with a suitable outfit of jacks, small tools, etc., will give a roundhouse force every facility needed for doing work promptly. Drop pits should be provided, and in the large houses it is better to have one pit for driving wheels and another for truck wheels, the latter pit being constructed so that the wheels can be transferred laterally and brought up to the floor between the tracks. For boiler washing purposes, we believe in supplying a duplex pump of ample capacity, capable of supplying a pressure of not less than 120 lbs.

We believe that it should be the aim of every large roundhouse to perform the heavier work on engines on pits in close proximity to the machine shop. On these same pits the work of boiler washing should be done, as, at that time, it is usually practicable to do considerable other work on the engine. In fact if the roundhouse work is handled properly, the washing out of engines need not be such a bugbear as it often is. If an engine, in arriving at a house, requires repairs that would take six, eight or ten hours, the boiler can be washed out at the same time, even though it is not the regular wash-out day for that engine. Then, when the engine goes out it will run longer before being again subjected to the delay incident to the washing out. If roundhouse work is to be handled in this manner, the work section and the washing-out section of the house should coincide, and that portion of the house, as already stated, should be near the machine shop, and in it should be located the drop pits and other facilities for doing heavy work.

If it appears to some that the roundhouse facilities recommended in this report are more elaborate and complete than are provided in modern practice, we would call attention to the fact that engines are getting larger and that the strain to which the various parts are subjected is much greater than in engines built a few years ago. If large engines are to make good mileage between shoppings, they must have excellent care in the roundhouse. Many minor repairs in the smaller engines that could be safely permitted to go for a trip or two, until there was time and opportunity to do the work, must be taken care of at once on the larger engines in order to avoid failures on the road and damage to the engine. Furthermore, engines of all sizes are compelled to work harder to-day than they ever did before, and the hard work locates all weak spots and exposes poor roundhouse work in a manner that is mortifying to the mechanical department and expensive to the company.

A LOCOMOTIVE BUILDER'S OPINIONS OF THE TWO-CYLINDER COMPOUND LOCOMOTIVE.

With special reference to the two-cylinder compound, Mr. J. E. Sague of the Schenectady Locomotive Works expressed opinions before the convention of the Master Mechanics' Association as follows:

In regard to the attitude of the builders of compound locomotives, I can speak to some extent for the Schenectady Locomotive Works and say that we favor the compound engine very thoroughly. We have had very flattering reports from most of the compounds we have built during the last six or seven years. We consider the compound engine entirely out of the experimental stage. We expect, however, to improve the details from day to day, and think that in ten years from now our compound engine may be materially different from what it is to-day.

Some of the objections raised to compound locomotives at the beginning of their use in this country are interesting reading now. It was objected to the two-cylinder compound that the low pressure cylinder would be unduly large for heavy locomotives; as a matter of fact, no cases have arisen in our experience in which the large size of the low-pressure cylinder was a governing factor. The limiting clearances in the case of heavy two-cylinder compounds are generally the clearance of the cab and the clearance from the track of the main crank pin, the same as for simple engines.

We do not urge the compound engine in season and out of season. We believe it is a subject in which the mechanical men should have the decision. I think the hesitancy in using the compound locomotive on some roads is due to the fact that they think compounds are in a state of development, and that by waiting two or three years they may get a better compound engine than now. I should hardly think that that attitude is a good one because for heavy freight service, at least, the compound engine is surely sufficiently better than the simple engine at this date.

There seems to have been a tendency to decry two-cylinder compounds to some extent for passenger service. I believe that the two-cylinder compound engine is thoroughly well adapted to passenger service, and in some cases will effect as much saving in passenger service as in freight service. There is, however, not generally the same chance to effect saving in passenger service as in freight service, as the simple passenger locomotive operates usually at a better rate of expansion than the freight locomotive and, therefore, is more economical. There is, for this reason, not the same opportunity for saving by compounding. This applies to all types of compound locomotives. In one case trials were made of two locomotives, one simple and one compound, for passenger service. The indications were that the compound engine

was better for certain heavy divisions where the grades were long, and the simple was, if anything, better on some undulating divisions. The result was that we got an order for duplicate engines, part simple and part compound, but before the order was executed we were asked by the officials of the road if they could not change the entire order to compound locomotives.

One feature in which the compound locomotive compares unfavorably with the simple locomotive in passenger service is the weight of reciprocating parts, and this has not been touched upon in this discussion. It is an impossibility to make reciprocating parts as light in compound locomotives as in simple locomotives. We have urged for years before this association that reciprocating parts should be reduced to the minimum, and a number of builders have done all they could, and strained a point perhaps, to make the pistons, piston rods and crossheads light, for the purpose of diminishing the reciprocating counterbalance on the track, and this has been lost sight of somewhat in compound locomotives for passenger service. We think it would be well to state in locomotive specifications that the dynamic effect upon the track must not exceed a certain amount, say 25,000 pounds for each driving wheel at 60 miles an hour. In order to meet such a condition we would have to consider carefully the weight of the reciprocating parts. We are now generally called upon to balance the locomotive so that it will ride easily, and I have only known two cases in which the railway has analyzed the effect of the reciprocating parts upon the track.

Another point occurs to me in regard to the statement in this discussion, that the compound locomotive occupies an unfortunate position when in use among a number of simple locomotives. My experience has been different from this. We recently built a compound locomotive for service among a lot of 18 simple locomotives. The pooling system was used and the results of the compound locomotive were so favorable that the men tried to get the compound engine in preference to the simple engine.

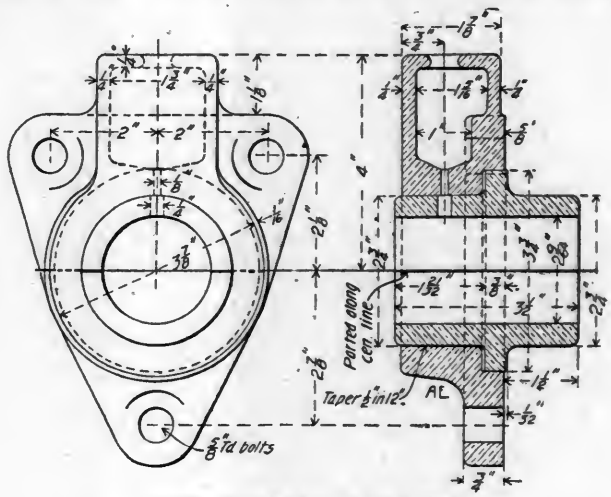
End doors in passenger cars for suburban and elevated railroad service seem to have decided advantages over side doors for rapidly delivering and taking on passengers. This will surprise those who have not given the subject careful thought, because it seems at first almost self-evident that the greater the number of entrances the quicker the loading. The "Railroad Gazette" investigated this subject in 1894, and in a recent issue presents interesting figures comparing the two systems. The average length of stop on the Manhattan Elevated with end doors only is put at 12 to 15 seconds, while that of the London Underground is 30 seconds with side doors at each compartment. Mr. R. H. Soule, when in South Africa, a short time ago, noted the average length of stops on the local trains of the Cape Government Railway to be 22 seconds with side doors, which he afterward compared with almost exactly similar suburban service on the Illinois Central in Chicago, where the average stop was 11.5 seconds. The latter service had end doors. The reasons given for the better results with the American cars with end doors are the assembling of passengers at the ends of cars before reaching a station and the possibility of taking on a group of passengers from a platform without the delay occasioned by a selection of seats or compartments before the train starts. In our cars the seating may be done after the train starts, whereas in the side-door system a passenger may detain the entire train while he picks out a seat to his liking. The side doors must be closed by the train men, which causes additional delay.

Dr. Winthrop E. Stone has been chosen President of Purdue University, to succeed the late Dr. James H. Smart. Dr. Stone has been Vice-President of the University for several years.

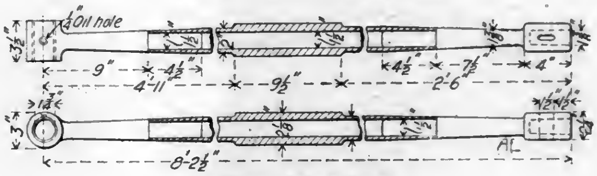
HOLLOW VALVE STEM AND GUIDE.

Richmond Locomotive Works.

A neat design of hollow valve steam, as made by the Richmond Locomotive Works, is shown in the accompanying engraving, and we also show a drawing of the guide in which the enlarged portion of the valve stem works. This valve stem is made of 2-inch hydraulic pipe into which the solid ends are welded. The pipe is upset for a distance of 9½ inches at the center in order to avoid weakening by wear. As the length is over 8 feet in this instance, and often as great as



Guide for Hollow Valve Rod.



Hollow Valve Rod.
Richmond Locomotive Works.

9 feet 6 inches, it is desirable to furnish a guide, which, in this case, is in the form of a bushing made in halves and tapered so that it may be drawn up easily to suit the valve stem. To take up lost motion, due to wear, the edges of the split bushing are pared off and it is drawn in closer than before, so as to close to the correct position for the stem. These hollow valve stems are in use upon a number of 10-wheel engines on the Southern Railway and also on passenger engines of the same type where unusual length was involved, on the Plant system and the R. F. & P. R. R.

In speaking of improvements in the compound locomotive, Mr. W. S. Morris of the Chesapeake & Ohio recently said: "The intercepting valve we are using is of the same design as that used eight years ago, and we have not yet found room or reason for improvement. The one referred to is working to-day as well as when it was first applied, and has not cost a cent for repairs. In the slide valve and steam distribution considerable improvement has been made. In this connection I refer to the application of the Allen valve, having the auxiliary port so arranged in relation to the steam ports in the valve face of the cylinder, that it serves as an exhaust port in the early part of the exhaust period, thus relieving the back pressure in the cylinder to a considerable extent, especially at high speed. By special investigation we have found with an engine on which the double-ported valve was put in the place of the old plain valve a speed of 26 to 39 miles per hour indicated a gain of 18 to 41 per cent. in power comparatively, and would undoubtedly have continued at that rate still higher if we had cards from the plain valve for comparison at higher speed."

CORRESPONDENCE.

CAST STEEL DRIVING WHEELS.

To the Editor:

Some time ago (February, page 43, and March, page 90, 1900) you published in the American Engineer two articles on cast steel wheel centers illustrated by examples of the latest practice. As I have been trying to get permission from some of the railway officials to make our centers with rims cut in four places, I had the gist of your articles translated into Russian, and also a sheet of drawings made representing your cuts as an argument in favor of my proposition. As it may interest you to see what your article looks like when done into Russian, I herewith enclose a copy of it and one of the sheets of drawings.

W. F. Dixon,
Chief Engineer Sormovo Works.

Nijni Novgorod, Russia, June 17, 1900.

[This cutting of rims of cast steel driving wheels brings out differences of opinion. Mr. Prince, of the Philadelphia & Reading, leaves them solid and uses elastic moulds. Mr. F. W. Webb, of the London & Northwestern, does not find it necessary to cut them. In neither of these cases has there been any trouble.—Editor.]

TRAIN LIGHTING FROM THE CAR AXLE.

To the Editor:

In view of the two appalling railway accidents that recently occurred almost simultaneously in Georgia and Wisconsin, in which a large number of passengers were burned to death through the conflagration and explosion caused by the use of oil lamps in the cars, I deem it not inappropriate, through the medium of your valuable paper, to call the attention of railway officials to the system of electric train lighting from the car axle, the use of which on passenger cars absolutely prevents the possibility of conflagration or explosion in case of a railway accident or wreck. This system, which is known as the "Axle Light" system, is in use on several of the leading railway lines and is already growing in favor and in use because of its superiority over all the old methods of car lighting, its safety in case of railway accidents being only one of its many attractions for the American travelling public.

JOHN N. ABBOTT,
Vice-President and General Manager,
Consolidated Railway Electric Lighting & Equipment Co.,
100 Broadway, N. Y.

WANTED—A GOOD RAILROAD.

To the Editor:

I have read your article, "What Motive Power Officers are Thinking About," in the March number of the American Engineer. The entire article is readable and to the point, but I am most directly interested by the statement that "subordinates should be selected with a view of the possibilities of advancement." This seems quite reasonable, and I certainly will not attempt to contravert it, as the principle involved should operate to my advantage.

I am a stenographer, 26 years of age; I have had two years' experience in the motive power department of a railway, in addition to a previous experience of five years in connection with correspondence in general office work, and a college education. During the two years I have been engaged in railway work I have obtained a pretty thorough insight into the office routine and correspondence of a motive power department and have, so far as I can say, given entire satisfaction to my employers. For my services I have received a small salary and the above-mentioned experience, the value of which I will not deny. However it has struck me forcibly that the officials of the road by which I am employed do not trouble themselves greatly with the "advancement of subordinates," and I would be thankful for any information leading to the discovery of a railway whose officials devote more thought to this subject. You might be able to help me in this respect, or possibly you may consider my letter worthy of publication as an indication of the interest with which your articles are read. If so I shall certainly deem it a favor.

I presume your article has more particular reference to employes possessing technical knowledge in connection with motive power department matters, but I think you will agree that the proper handling of office work and correspondence is of perhaps greater importance than has heretofore been admitted, and should therefore receive more attention than has been devoted to it. Possibly you may consider this suggestion as worthy of attention, and devote more space to this class of work in your valuable publication in future. In the meantime if you are able to direct me to such a railway as I have mentioned above I shall be grateful. "Reader."

[Comments upon this letter will be found on the editorial page of this issue.—Editor.]

DIRECT CURRENT MOTORS FOR VARIABLE SPEEDS.

To the Editor:

In looking through your July issue, we find a quotation from the paper read by Prof. W. S. Aldrich, at the Mechanical Engineers' Convention, as follows:

"The induction machine as it stands to-day is probably the most perfect motor yet developed from the standpoint of electric transmission in factories and mills. It may be started and operated from any point at any time at practically any load and speed within its predetermined ranges. It will permit of higher lineal speeds than are possible with any other type and cannot be burned out from rough usage and overloads. This makes the induction motor especially fitted for driving almost all classes of shop machinery."

It is our opinion that Prof. Aldrich became unduly enthusiastic over the induction motor when he wrote those lines, for the reason that the facts do not bear out the assertion. The statement that "the motor cannot be burned out" is too strong. It might be true in a machine designed with that point alone in view, but in the commercial machine there are limiting conditions. For instance, a Westinghouse No. 4 crane induction type motor, running normally at 825 revolutions with 200 volts, may be run for one hour at 720 revolutions; at 670 revolutions for 15 minutes; at 620 revolutions for 2½ minutes; at 500 revolutions for 1 minute, and at the end of the time limits given the secondary has reached a limiting temperature.

As to the statement that "the induction motor can be started from a distance." This is true of but one make of these motors, and while some conditions may demand that a motor be started from a distant point, it would eliminate the advantages of competition to specify this feature. We doubt if any business man would consider it good policy to place such limitations upon his affairs. Regarding variable speed for induction motor service, we doubt its practicability, and one of the best assurances that our position is well taken comes to us in the July 7th issue of the "Electrical World and Engineer." On page 34 of that issue will be found a description of the new works of the Westinghouse plant at Havre, France. It states that "the big crane will be operated by the 500-volt direct current," although constant speed induction motors are used to operate shafting. If variable speed induction motors are thoroughly practical and desirable, why have they not been installed upon this crane? After an experience of several years with the induction motor on their crane at East Pittsburg, the judgment of the manufacturers in selecting the direct-current motors for crane service practically proves that the induction motor is not desirable where variable speeds are necessary.

In further support of our position, permit us to quote from the report of the committee appointed by the American Railway Master Mechanics' Association, of which Mr. Geo. Gibbs, a man of wide practical experience and who is intimately associated with the manufacture of the induction motor, was chairman. This report says: "For alternating motors the same considerations as for the 'direct' apply, but variable speed running in this type for tool driving motors is not practicable." "The disadvantages of the alternating-current motor are its high speed and the fact that it is essentially a constant speed machine."

After a consideration of the above facts, do you really think that the statement made by Prof. Aldrich that "induction motors are specially fitted for driving almost all classes of shop machinery" is true?

We certainly do not think so, and when we further consider the statement made by the committee above quoted, that "It is the belief of your committee that one of the great advan-

tages of electric driving is in the possibility of simple speed regulation," we are not giving undue praise to the direct-current machine when we say that it is the only practicable motor for direct connection to machine tools or other machinery requiring a variable speed.

In connection with this subject, it is also interesting to note what this same committee says regarding the selection of a system. We quote as follows: "For long distance transmission, say one mile or more, alternating transmission is almost a necessity; for shorter distances, and in cases of isolated plants in compactly grouped railway shops, the direct-current system can be employed without any practicable disadvantages in waste of power in transmission line."

This same conclusion has been arrived at by Mr. Alexander Seimens, who, in the discussion of the paper on the subject of electric transmission before the Institution of Civil Engineers, said:

"The advocate of any one system desires to see that system adopted everywhere and deprecates any competing scheme. Such a controversy is now taking place between the three-phase system and the direct-current system; but they both have their good points. To my mind the alternating currents have the great advantage that the currents can be generated at a low voltage, transmitted at a high voltage, making it possible to use thin conductors, and then used at the motors at a low voltage, a transformation taking place at each end of the line. The great drawbacks of the three-phase induction motors are that they give their best efficiency at one particular speed, and if they are slightly overworked they stop. I have invariably found that for any small distance like 200 to 1,500 yards, a direct-current plant is cheaper than the three-phase plant; but for larger distances, the calculation comes out differently. The great ease with which the direct-current motors can be regulated and run at different speeds, together with their corresponding good efficiencies, induce me to be a strong advocate of direct-current motors. Another reason why I advocate these machines is that the three-phase currents for lighting are not so simple as the direct-current, as the current has always to be kept exactly equal in the three branches, or there will be a disturbance."

These remarks, coming from so eminent a gentleman as Mr. Seimens, and the remarks quoted from the report of the very able committee appointed by the American Railway Master Mechanics' Association, should have great weight with intending purchasers of electric machinery for power and lighting.

Bullock Electric Manufacturing Company,
Frank G. Bolles, Manager Advance Department.

THE FERRELL WOOD FIREPROOFING PROCESS.

By invitation of the New York Shipbuilding Company a large and distinguished party of representative business men from New York, Philadelphia, Boston and other large cities, gathered at their yards in Camden, N. J., recently, to witness an extremely interesting and practical test of the merits of wood, fireproofed by the Ferrell process, owned by the United States Fireproof Wood Company.

For the purpose of the test two small buildings, 6 ft. square and 12 ft. high, had been erected, each built identically the same, except that one was built of ordinary wood and the other of fireproof wood; the outside was built of white pine, the inside of poplar, with cherry and ash casings, the floors of Georgia pine and the roof of cypress shingles.

The houses were supported at the corners and raised 2 ft. above ground, with a large chimney in the center of the roof and rising 4 ft. above it; the lower portion below the floor being built of ash and open lattice work, leaving it perfectly free to the passage of air. Under each house and against the sides were piled shavings, cotton waste and wood saturated with oil, and at a given signal both houses were fired. In a few minutes the house built of ordinary wood was on fire, the flames spreading rapidly, and in 16 minutes it fell to the ground in ruins.

On the other house the effect was remarkable; the flames from the fuel had died out, leaving no traces whatever, except a thin charred and blackened surface where they had come in direct contact with it—just as would have been done to asbestos under the same conditions—but the house remained structurally intact and uninjured. More wood soaked with oil was then piled inside the house, the heat being so intense as to crack and melt the glass; this was done again and again, but with a similar result; it was impossible to set it on fire.

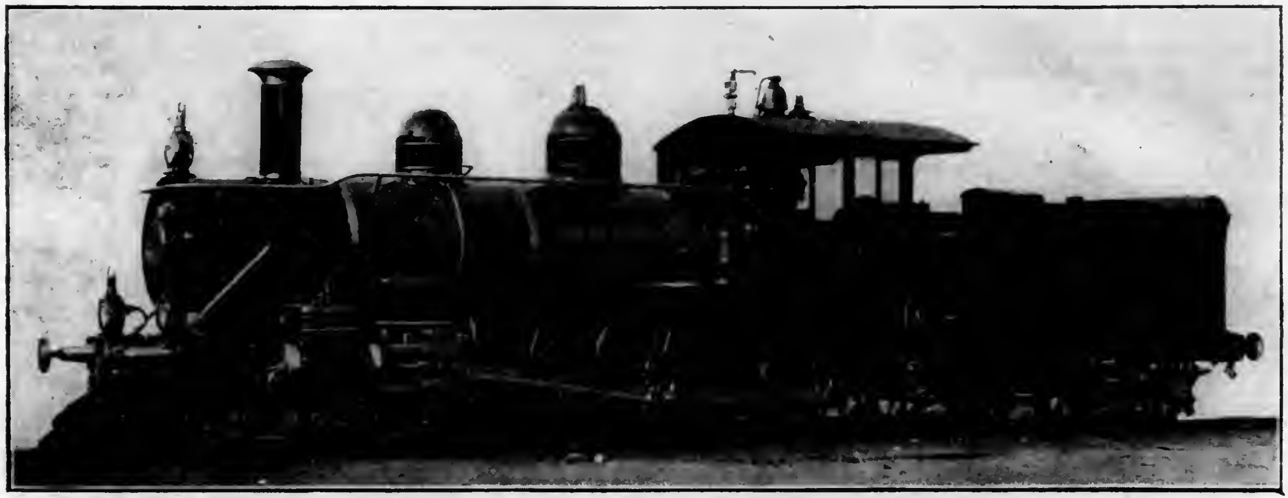
In addition to this test two other houses, 5 ft. square and 8 ft. high, had been built, one of fireproof wood and another of ordinary wood, with live electric wires coiled around and through from floor to roof; the current was turned on, but no effect was noticeable on the fireproof wood save the blacking of it by the glowing wires at the points of contact, while the ordinary wood was in flames in six seconds, the tests terminating by the melting of the wires. Tests were also made with the Bunsen blast burner and a flame of 3,000 degrees Fahrenheit projected against the treated wood, a flame powerful enough to melt iron or copper, but the wood merely charred and glowed where the flame was directly applied, the part surrounding it remaining cool and unaffected by the intense heat.

An exhibition was also given showing samples of the treated wood of all kinds, oiled and varnished, which showed that the treated wood could more readily take and hold the oil and varnish than the untreated. Pictures of the demonstrating and testing plant, which is located at 2218-20 Race Street, Philadelphia, where the process can be seen in actual operation, were also shown and the process explained.

The demonstration was not merely to show that wood could be made fireproof, for that has been done before, but to show that the Ferrell process can, in a short time, heart-treat thoroughly all kinds and sizes of wood, whether green or dry, in its natural state, just as it comes from the lumber yard; and without any previous boiling or drawing out of the natural juices; and that, at a cost so very little higher than the untreated wood that it can be used commercially for all purposes, and not be confined to the higher grades of woodwork as it has been heretofore; in fact the wood can be treated quicker and cheaper than by other processes. The chemical solution used in the fireproofing is non-volatile, thus insuring the permanency of the treatment; it is also non-hygroscopic and non-corrosive. It is forced in under heavy hydraulic pressure, mechanically controlled, without in any way injuring the fibrous tissues or changing its color or natural qualities. The treatment in every way tends to preserve and improve the wood, making it take paint, oil and varnish better, besides being as easy to work with tools as the untreated wood.

The right to use the patent in New York and adjacent territory has recently beeen purchased by the New York Fireproof Wood Company, and they have now in course of erection at Long Island City a plant covering three acres of ground and capable of treating 15,000,000 ft. of lumber annually. By direction of President Henry G. Morse the tests were conducted by Captain Wm. G. Randle, Treasurer of the New York Shipbuilding Company, and the results were in every respect satisfactory.

The causes of flange wear of car wheels has been studied and discussed at considerable length before the St. Louis Railway Club and one of the most important contributions was made recently by Mr. P. H. Griffin, President of the New York Car Wheel Works, in connection with the differences in diameter of wheels on the same axle. If one wheel is larger than the other the larger one will advance ahead of the smaller one as far as the flanges will permit and both wheels will then revolve with the flanges crowding against the rails. It is evident that this will cause flange wear and that it becomes worse with increasing speeds and loads. Mr. Griffin refers to the well-known fact that wheels of different diameters are frequently found under new cars. In spite of the greater care which is now exercised in taping and gaging wheels, there is room for improvement in this direction. Mr. Griffin believes that the average difference in diameter of cast wheels is now about ⅛ inch and considers present practice in fitting wheels as far from what it ought to be. Flange wear is known to increase the resistance of trains and this, in addition to the incidental wear and tear of the track and equipment, constitute good reasons for taking this question with vigor. It is increasingly important as speeds become higher and loads become heavier.



TEN-WHEEL SIMPLE PASSENGER LOCOMOTIVE.

FINLAND STATE RAILWAYS. RICHMOND LOCOMOTIVE WORKS, *Builders.*

Weights: Total of engine............90,000 lbs.; on drivers ....65,000 lbs.; total engine and tender...........117,000 lbs.
Wheel base: Driving ....12 ft. 6 in.; total engine and tender........ 39 ft. 11¼ in.
Cylinders: 16x24 in. Wheels: Driving............62 in.; truck.... . .. 33⅞ in.; tender.......... 37 in.
Boiler: Radial stay, straight top ... .52 in. diameter; pressure..... ......180 lbs.
Firebox: Length....56¾ in. width....37 in.; depth, front....68¼ in.; back....67 in.; grate area 15.2 sq. ft. Tubes, 170 2-in...12 ft. 7⅝ in. long.
Heating surface: Tubes............1,114 sq. ft; firebox...... ....80 sq. ft.; total...........1,194 sq. ft.
Tender.......... six-wheel. Tank capacity.......... 2,100 gals. water, 5 tons coal.

TEN-WHEEL PASSENGER LOCOMOTIVES.

Finland State Railways.

Built by the Richmond Locomotive Works.

The locomotive shown in this engraving is one of ten just completed for the Finland State Railways by the Richmond Locomotive and Machine Works. Nine of them have been shipped direct to Helsingfors, Finland, and the tenth has been sent to the Paris Exposition. These engines are not heavy or large in comparison with recent practice here; they have copper fireboxes, copper staybolts and brass boiler tubes. The tender is carried on six wheels, the first pair being in pedestals and the other two pairs in a four-wheel swiveling truck. The cab is of steel. The air brakes are of the Westinghouse "European" pattern with the driver brake shoes in front of the wheels. The design, except as noted with regard to boiler materials and a few other details, is similar to usual American practice. The valves are the "American balance," by the American Balance Slide Valve Company, Jersey Shore, Pa. The engines are lighted by Pintsch gas. The following are the chief characteristics:

General Dimensions.

Gauge	5 ft. 0 in.
Fuel	Coal
Weight on drivers	65,000 lbs.
Weight in working order	90,000 lbs.
Wheel base, driving	12 ft. 6 in.
Wheel base, total engine and tender	39 ft. 11¼ in.
Total length of engine and tender	50 ft. 9½ in.

Cylinders.

Diameter	16 in.
Piston stroke	24 in.
Piston packing	Cast iron
Piston rod, 2¾ in.	Steel
Piston rod packing	U. S. Metallic
Steam ports	1¼ in. by 15 in.
Exhaust ports	2½ in. by 15 in.
Bridge width	1 in.

Slide Valves.

Style	American balanced
Greatest travel	5¼ in.
Lap, outside	⅞ in.
Lap, inside	0 in.
Lead in full gear	1/32 in.
Valve stem packing	U. S. Metallic

Wheels.

Driving, number	6
Driving, diameter	62 in.
Driving centers	Cast steel
Driving boxes	Cast steel
Driving axle journal	6½ in. by 8 in.
Engine truck, style	Center bearing, swing motion
Engine truck wheels, diameter	33⅞ in.
Engine truck wheel centers	Wrought iron
Engine truck axle	Steel
Engine truck journals	4½ in. by 7½ in.

Boiler.

Type	Straight top, radial stayed
Working pressure	180 lbs.
Outside diameter, first course	52 in.
Thickness of plates in barrel	½ in.
Thickness of plates, roof and sides	½ in.
Seams, circumferential	Double riveted
Seams, horizontal	Butt sextuple riveted
Firebox, length	56¾ in.
Firebox, width	37 in.
Firebox, depth	Front, 68¼ in.; back, 67 in.
Firebox material	Copper
Firebox, plates	Sides, ½ in.; back, ½ in.
Firebox, plates	Crown, ½ in.; tube, ½ in. and ⅞ in.
Firebox, water space	Front, 4 in.; side, 3 in.; back, 3 in.
Firebox, crown stays	1⅛ in. "Brown" iron
Firebox, stay bolts	1⅛ in. copper
Tubes	Material, brass and copper; length, 151⅝ in.
Tubes	Number, 170; diameter, 2 in.; thickness, Nos. 12 & 15
Heating surface, tubes	1,114 sq. ft.
Heating surface, firebox	80 sq. ft.
Heating surface, total	1,194 sq. ft.
Grate	Style, wrought iron; C. iron dump
Grate area	15.2 sq. ft.
Exhaust pipe, style	Single
Exhaust pipe nozzle	3 in., 3¼ in. and 3½ in.
Smokestack, inside diameter	15¾ in.
Smokestack, top above rail	13 ft. 5 in.

Tender.

Weight, empty	27,000 lbs.
Frame	Steel
Wheels	Number, 6; diameter, 37 in.
Journals	Steel, 4 in. by 8 in.
Wheel base	9 ft.
Tank capacity, water	2,100 gals.
Tank capacity, coal	5 tons

STEEL VERSUS WOODEN CABS.

The relative advantages of wood and metal cabs have been considered by all mechanical officers and locomotive designers, and it probably looks to many that the future development of American locomotives will involve a much more extensive use of steel cabs conforming to the almost universal practice in foreign countries. Considerable can be said on both sides of the question.

In favor of metal cabs: Increased strength and durability, and thus lower cost of maintenance.

Against them: Greater first cost and increased weight.

Steel cabs are standard on all Southern Pacific lines, and their mechanical engineer, Mr. F. W. Mahl, says that the first steel cab built was in 1891 on the Southern Pacific system in Arizona. In July, 1895, nothing had been expended for repairs. Since 1895 no wood cabs have been built. In 1895 a number of 22 by 26-inch mountain locomotives were built with steel cabs. Nothing has been expended on them for repairs. It is reported that paint on metal cabs lasts longer than on wood. The Southern Pacific cabs are lined and have double roofs,

and are said by engineers and firemen to be as cool as wooden ones.

Against steel cabs: An increased first cost and increased weight. At present prices of material average steel cabs cost $100 more than wood. Their increase in first cost is probably justified, however, in view of the saving in maintenance. The increased weight is a more serious feature. Comparison of the weight of average designs roughly shows for small cabs 900 pounds increase, and large ones 1,300 pounds. Some special designs show 1,500 pounds or higher. This increase prohibits the use of steel cabs in some new designs where all possible must be done to save weight at the back end of engine to keep within driving wheel weight limits and obtain maximum boiler power. This would apply to many recent designs of large passenger engines, examples of which will readily occur to all. In other types the extra weight of steel cabs may improve the distribution. Many cases will occur in which increased weight is allowable in renewals where railroad men have latitude in new work as bridges and track get stronger and the bridge and track department grow less conservative.

Steel cabs are almost essential also in hot and dry climates, or where moisture and dryness are destructive to wood.—[J. E. Sague.—Topical discussion before Master Mechanics' Association.]

THREE APPLICATIONS OF ELECTRIC DRIVING IN SHOPS.*

Chicago Great Western Railway.

The new shops of this company at Oelwein, Iowa, were planned for electric driving throughout, the system being of the 220-volt direct-current type, with group-driven machine shop tools. The exhaust-steam method of heating is employed, using two fans, each driven by a 25-horse-power motor. An electrically driven transfer table furnishes means for all transferring operations, large and small, the shops being specially arranged to be served from this one table, which travels at a speed of 200 to 400 ft. per minute.

The electrical energy needed in winter, including power required to drive the heating fans, is:

Average electrical horse-power, without lights	325
Maximum electrical horse-power, with lights	450
Night load	65
Nominal motor capacity, horse-power	450
Nominal generator capacity, horse-power	525

The generating station is arranged with three equal units of 150 horse-power, an unusually liberal amount of power for the capacity of the motors connected—a fact in part accounted for by the large percentage of power used to run the heating fans and for the lighting.

General Electric Company's Shops.

The enormous plant of this company, at Schenectady, N. Y., is, as would be naturally supposed, equipped for electric driving, and represents their latest ideas.

In this plant the methods for driving of both light and heavy machinery may be studied. Small and medium size tools are in general driven by the group plan, the short lines of shafting being run by variable-speed motors mounted directly on the ends of the shafts, constituting a novel plan of driving without belting or gears, while large tools are driven by individual motors attached direct or by gearing.

A noticeable feature is the use of portable or shifting tools for very large work. These tools are provided with geared motors, the tool being moved to the work, instead of the work to the tool. This method is especially applicable for the machinery of very heavy and bulky product, but may be used to advantage for special light tools in railway shops, as is pointed out elsewhere.

The entire shops are served by the indispensable electric power crane. These are, in the larger sizes, provided with auxiliary hoists operating at fast lifting speeds for light work.

Their system of wiring and the type of motors deserve special mention. The motors are of the direct-current variable-speed type, and the speed is regulated by a combination of two methods, as follows: The distribution is on the "three-wire" system, the two outside wires having a voltage of 250 between them, while the middle wire carries a potential difference of 125 volts from the other two. The motors are wound for 250 volts, and are connected between the outside wires to run at a certain standard speed; for a lower speed the connections are switched to one outside and one intermediate wire, operating, therefore, at one-half voltage. From this lowest speed to the normal one at 250 volts a gradual speed rise is effected by weakening the magnet strength of the motor field; and, on the 250-volt connections, the motor is further speeded up by again weakening the field. It is seen that these valuable properties of wide speed range are obtained in a very simple manner.

Examples of the speed variation possible in these motors are:

4½	horse-power	motor	runs	at	400	to	800	revolutions	per	minute.
7	"	"	"	"	250	"	500	"	"	"
12½	"	"	"	"	150	"	300	"	"	"
15	"	"	"	"	130	"	260	"	"	"

Baldwin Locomotive Works.

These works illustrate one of the earliest as well as probably the most extensive examples of electric machine shop driving. It is not too much to say that their manufacturing methods to-day hinge largely upon changes made possible by the use of electric power, and that no other agency could be substituted wholly therefor except at incomparably greater expense in space, installation and maintenance. In these immense works, situated in the heart of a large city and employing 8,000 men, the fullest utilization of space and the utmost simplicity and rapidity of handling operations are essential, and many ingenious examples of the convenience and economy of electric driving are here to be seen.

The electric plant is of the 250-volt direct-current type, the generators being direct-connected and aggregating 1,550 horse-power normal capacity. The motors are almost exclusively of the multipolar belted type, and number 320, having a total rated capacity of 3,500 horse-power. Only about 5 per cent. of these motors are of the "series" type—an unusual condition, and due to the fact that the cranes are equipped with shunt motors.

About 950 horse-power at the powerhouse switchboard is required on an average to run the entire power plant, and this figure is fairly constant throughout the day.

Electricity was first introduced in the erecting shop for driving two 100-ton traveling cranes, and an immediate saving of 80 men in the laboring force was thereby effected. The possibility of this result is seen when it is noted that a crane is capable of lifting an entire locomotive, or the parts of same, thus allowing the erection of a large number of locomotives to be carried on in a contracted space and without interference or delays connected with manual handling operations. Hand-drilling operations were also largely reduced in this department by substituting electric portable drills.

In the wheel shop large economies resulted from electric driving. By remodeling the shop the overhead shafting was done away with, each lathe being equipped with a separate motor. The two long main aisles formerly necessary for handling the work in and out of the machines were utilized for additional lathes, giving about one-third more machines in the same floor space; and the shop was served by an overhead traveling crane, instead of the hand jib-cranes in former use. The result was a reduction of common labor force from forty men down to six, and a reduction of the time consumed in reloading a lathe from thirty to five minutes. The saving in power for this shop was also considerable, estimated at fully 50 per cent.

Similar results followed the introduction of electric driving in the frame shop, where the cutting out of overhead shafting and the use of traveling cranes enabled them to cut down the laboring force 60 per cent.

In all the above cases the use of cranes was made possible only by the electric driving of the tools to be served by them.

The motors are, in general, connected to large individual tools by belting from a self-contained countershaft and speed-changing drive mounted on a frame connected with the tool. Group-driving is employed for small tools from short-line shafts.

The cranes are of the single-motor type, having a shunt motor belted to a train of gearing and clutches. This type of crane is highly thought of in these works, and is considered superior to the three-motor type in its smoothness of action, ease and accuracy of handling and reliability. It is, however, higher in first cost than the latter type.

The cost of electric power at these works has been estimated at about $1,200 per week, which sum includes cost of fuel, engineers and firemen, labor and material for repairs of power-house, lines and motors. It also includes interest and depreciation on first cost of plant. It is interesting to note that this entire amount is about 1.2 per cent. of the shop pay-roll.

* Appendices to report on Power Transmission by Shafting vs. Electricity. Master Mechanics' Association. See American Engineer, July, 1900, page 230.

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Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Special Notice.—*As the* American Engineer and Railroad Journal *is printed and ready for mailing on the last day of the month, correspondence, advertisements, etc., intended for insertion must be received not later than the 20th day of each month.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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A letter from a young stenographer which appears under Correspondence in this issue suggests what we consider one of the best opportunities for improvement in railroad service, the development of humanics in all departments. We withhold the name of the writer of this letter at his own request, and we commend the spirit of honest ambition which he expresses. We are glad to print this protest against indifference toward one of the most important fundamentals of organization and management. There are many cases of people who "do not trouble themselves greatly with the advancement of subordinates" and the number of roads looking outside of their own forces for leading men is becoming alarmingly large. As a broad principle it should never be necessary to look beyond our own subordinates for a man to place in a responsible position, and if the subordinates are selected carefully and encouraged systematically there will always be a candidate at hand who is ready for advancement. As to this young man, can anyone give us the name of the railroad he is looking for?

A 600-h. p. four-cycle gas engine at the works of the John Cockerill Company, Seraing, Belgium, showed excellent results in a recent test. The gas is obtained direct from the Bessemer blast furnaces and, on its way to the engine, passes through dust collectors and receives a proportion of steam to cool it and increase its density. In the tests the thermal efficiency of the engine was 27.16 per cent., the net efficiency about 20 per cent., and the mechanical efficiency between 73 and 80 per cent. The consumption of gas was about 31 cubic meters per horse-power hour. Of the total amount of heat supplied, 20 per cent. was converted into work, 20 per cent. went out in the exhaust, and 52 per cent, into the circulating water.

The New York harbor fire horror of June 30 surprised everyone because of the feeling that the fire protection of modern ships was adequate to prevent such disasters. The rapidity of the spread of the fire and its extent were overwhelming; not allowing time for preventives to be brought into action. The lesson to be learned from this loss of 175 lives and $7,000,000 worth of property is an important one, because a similar combination of circumstances may occur at almost any time in New York. Better piers of steel and concrete, with fire-resisting partitions, are needed. Cotton bales of the cylindrical type are known to be much safer than the old forms which contributed to this disaster. Fireproofed wood is now available and may be used in ships with no disadvantage except a slightly increased cost. The cabin and stateroom ports, or "dead eyes," should be made large enough to admit the body of a man. The most horrible feature of the whole disaster was the death of many whom the would-be rescuers could see and talk with through these openings, which were not large enough to permit of escape. There seems to be no reason why these things can not be done.

Malleable iron is being sold as cast steel for small castings, and the fraud as discovered recently in the department of tests of one of the large railroads, is interesting. A casting bought as cast steel, and for which the corresponding price was paid, was accidentally broken and the fracture was that of malleable iron. Complaint was made to the makers and the part returned as proof. This brought indignant protests from the manufacturers and the sample was returned to the purchasers, but the appearance of the fracture had changed and it then looked like that of tool steel, so fine was the grain. This transformation interested the test officer of the road to the extent of a patient investigation, which revealed the fact that the fracture of malleable iron may be changed to that of very hard and fine steel by heating and chilling. By doing this, fractures at one end of a piece of malleable cast iron may be so much like that of fine steel as to deceive even the expert, while that at the opposite end is the characteristic fracture of malleable iron.

"There are two peculiarities in the compound not brought into general notice, which are of inestimable value to the railroad, perhaps as much so as all the other advantages combined," said Mr. W. S. Morris of the Chesapeake & Ohio at the recent Saratoga convention. "One of these is that of starting a heavy train as compared with the simple engine. The simple engine can seldom start its train without taking slack, and often repeats this process three or four times. The consequent shocks to draft rigging and cars are well known, and are probably the hardest part of the service, few riggings being strong enough not to be subjected to a strain far in excess of their elastic limit. The starting of the compound differs considerably in this respect from the simple engine, especially since enginemen have become familiar with the handling of the machine. There is no need of taking slack, and consequently the slack that generally exists in the train before starting is taken up with care and gentleness, and brings the engine to an apparent standstill about the time when all couplers are stretched. From this moment the actual starting takes

place, and, as there is no lost motion left, there can be no appreciable jerks in the train. This valuable advantage cannot be overestimated, as it necessarily reduces the repair expenses and prolongs the life of the rolling stock in general. The other peculiarity is the possibility of utilizing from 33 to 35 per cent. of the weight on the drivers for tractive power in emergency. This feature, however, is not so easily explained, but makes it possible to handle the trains under all conditions without resorting to the destructive utilization of the slack."

The comparative evaporative values of the various tiers of tubes in a water tube boiler in terms of evaporative power have been obtained by Messrs. Niclausse of Paris, the builders of the Niclausse water tube boiler. A specially constructed boiler was used, with 24 tubes in 12 stages of two each. Each stage delivered its steam separately and was independently supplied with feed water, which was carefully measured. The results are available in a paper read before the British Association by Mr. Mark Robinson, and reported in "The Engineer," Sept. 22, 1899. The tests were carried out at rates of combustion varying from 10 to 61 pounds per square foot of grate, and the remarkable result was obtained that the proportionate evaporation in each stage of tubes was almost exactly the same at all rates of combustion. The lowest stage of tubes directly exposed to the radiant heat evaporated nearly one-quarter of the whole, the first three stages evaporated nearly one-half, and the first six stages evaporated two-thirds of the whole. The first three rows of tubes gave 7½ square feet of heating surface per square foot of grate, and the first six rows gave 15 to 1. The top row evaporated but 3¾ per cent., and the law of decreasing efficiency was plainly indicated. The water tube boiler lends itself very nicely to a test of this kind because of the convenience with which the evaporation may be measured in sections, and it would be a great help in locomotive designing if the same was true of fire tube boilers. The tubes which add but little to the valuable heating surface are just as heavy as those which are more efficient and in the locomotive the front ends of tubes are as heavy as the back ends. The relative value of each foot of length under the working conditions of present practice would be most valuable information.

The opinion of the merits of large grates by an intelligent and observing fireman are worthy of most considerate attention. Mr. Fulton in his article in this issue says a number of convincing things about the large grate. Two of them stand out prominently as good business reasons for increasing grate areas. First the limitations of the physical strength of the fireman. Unless larger grates are used there will be serious agitation for two firemen on every large engine, and it will soon be necessary to come out in the open and call them both "firemen" instead of calling one of them a "brakeman" or "coal passer." We have now reached the extraordinary record of five tons of coal shoveled through a locomotive firedoor in an hour, and in contrast with this let us note that in the most successful stationary practice, where good firing is sought in connection with best efficiency, only one ton per hour is expected of one man. He is fully occupied in placing this amount properly on the grates. In England three tons handled in a passenger run of 150 miles is considered very severe. The second point made by Mr. Fulton is the possibility of burning poor coal. The time will come when the grates will be studied with special reference to the coal used and the active area of fire will be adjusted in accordance with the special requirements of the fuel. In the combustion of locomotive fuel there is a wide and promising field for experiment and investigation, and the way motive power men are taking up the increase of grate areas for soft coal seems to us the most promising improvement ever made in American locomotive practice. It will soon seem strange that grates were kept narrow so long and that the grate area question has been considered as largely independent of the quality of the fuel. The strength of the opposition to larger grates for soft coal seems to have come from the famous opinion of D. K. Clark: "There may be too much grate area for economical evaporation, but there cannot be too little, so long as the required rate of combustion per square foot does not exceed the limits imposed by physical conditions." This celebrated experimenter based this conclusion on tests made with coke, and his opinion, we believe, has been accepted in locomotive practice without appreciating that fact. It is now evident that firebox and grate proportions must be considered with reference to the characteristics of the fuel, and we are justified in placing this subject among those of first importance in locomotive progress.

NOTES.

The water tube boiler has had a marked effect in increasing the permissible amount of heating surface in marine practice. With less weight in the boilers than was formerly necessary, the heating surface is much more liberal. In a review of the warship construction in 1899 in the English Navy "Engineering" states that the minimum for the year was 2.4 square feet per indicated horse power against 1.7 square feet formerly.

An inexpensive dust guard, which has given excellent service and has been adopted as standard on the Southern Pacific System, is made of common pine wood and lined on both sides by either old plush or canvas (canvas preferred), and fastened with clout nails. The hole in the wood is ¼ inch larger than the axle on which it is to be placed, and the hole in the canvas is smaller than the axle fit. When put on the axle it makes a snug fit, and after being in service for a short time becomes saturated with oil, collecting all dust, and is practically dust proof. These dust guards, which cost but nine cents each, were spoken of very heartily by Mr. V. Lemay in a recent paper before the Pacific Coast Railway Club.

In 1879 the car accountants expressed the opinion that "the per diem plan for the use of cars is not feasible." Twenty years later they resolved that "this association is in favor of a per diem method of settlement for the use of cars." The "Railway Age" takes comfort from this mark of progress and says that in only one department of the transportation industry to-day are there great leaks. That department is the freight car service. With the constantly decreasing margin between ton-mile revenue and ton-mile cost the responsible financial managements are compelled to seek economies. "Doing this they cannot overlook the fact that a system under which the average freight car movement is only some thirty miles a day is essentially extravagant and wasteful."

The use of chilled cast iron for coast defence turrets is not new. According to Dr. Thurston, writing recently in "Science," the subject was investigated by our government in 1865 and since then about 40 of them have been built for various defences in Europe. Mr. P. H. Griffin, well known for his work in chilled iron car wheels, has recently acquired from the Krupps the control of the Gruson patents in this country, and has formed a company with works at Chester, Pa., for the manufacture of these turrets. With the knowledge of chilled iron which has been developed in this country, together with plenty of the best chilling irons, the process may be expected to improve, and the remarkable characteristics of chilled cast iron may become important in defenses as well as in transportation.

PERSONALS.

Mr. A. E. Taber has been appointed Master Mechanic of the Great Northern at Kalispell, Mont.

Charles R. Tunks, Master Car Builder of the Lake Shore & Michigan Southern, died suddenly June 29, at the age of 50 years.

Mr. J. C. Reed has been appointed Master Mechanic of the Seaboard Air Line at Portsmouth, Va., to succeed Mr. C. B. Royal.

Mr. R. P. Schilling, General Foreman of the Norfolk & Southern, at Berkeley, Va., has been appointed Master Mechanic of the D. L. & W., at Utica, N. Y.

Mr. James T. Wallis has been promoted from the position of Assistant Master Mechanic of the Altoona shops of the Pennsylvania to be Assistant Engineer of Motive Power at Altoona.

Mr. D. F. McBain, formerly Traveling Engineer of the Michigan Central, has been appointed Master Mechanic of the western division of the road at Chicago to succeed Mr. J. G. Riley, resigned.

Mr. L. G. Parish, Master Car Builder of the Lake Shore & Michigan Southern at Chicago, has had his jurisdiction extended over the Toledo division, which was under the charge of the late C. R. Tunks.

Mr. G. S. Edmonds, who was formerly connected with the Mechanical Engineer's office of the New York Central & Hudson River R. R., has been appointed Mechanical Engineer of the Delaware & Hudson.

Mr. H. Monkhouse, formerly Superintendent of Motive Power of the Chicago & Alton, has resigned to become Superintendent of Motive Power of the Chicago, Indianapolis & Louisville, to succeed the late W. P. Coburn, who died suddenly June 21.

Mr. H. T. Herr, formerly with the Denver & Rio Grande, has been appointed Master Mechanic of the Southeast Division of the Chicago Great Western, with headquarters at Des Moines, Ia., to succeed Mr. F. T. Slayton, who has resigned. Mr. Herr was educated at the Sheffield Scientific School of Yale University.

Mr. L. G. Barger, who was for many years connected with the transportation department of the West Shore Railroad, and recently with the New York Air Compressor Company, has accepted the position of chief clerk to Superintendent Ketcham on the Morris & Essex Division of the Delaware, Lackawanna & Western Railroad.

Mr. George D. Brooke, formerly Master Mechanic of the St. Paul & Duluth, has been appointed Master Mechanic and Master Car Builder of the Iowa Central, at Marshalltown, Ia., succeeding Mr. B. Reilly, who has resigned. Mr. Brooke is succeeded by Mr. J. H. McGoff, under the management of the St. Paul & Duluth by the Northern Pacific.

It is reported that Mr. R. N. Durborrow, Superintendent of Motive Power of the Philadelphia, Wilmington & Baltimore, has been transferred to the same position in the Buffalo & Allegheny division, with headquarters at Buffalo, and that Mr. Alex. Kearney, Master Mechanic at West Philadelphia, will succeed Mr. Durborrow on the P. W. & B.

JASPER R. RAND.

Jasper R. Rand, who died Wednesday, July 18, was born September 17th, 1837, in Westfield, Mass., of a family dating its American ancestry from 1635 and including two colonial governors; and which was well represented in the Revolutionary War. He obtained his education in the public schools and academy of his native town and in Fairfax, Vt.

His earliest business connection was with his father, who was a manufacturer of whips when Westfield was the headquarters of that industry. In 1865 his father retired from business, and Mr. Rand and his younger brother, Mr. Addison C. Rand, succeeded him.

In 1870 he removed to New York and was for a time associated with another brother, Mr. Albert T. Rand, President of the Laflin & Rand Powder Company. In 1872 Mr. Addison C. Rand began the manufacture of the Rand rock drills and other mining machinery, and the two brothers subsequently organized the Rand Drill Company, with Mr. A. C. Rand as President and Mr. J. R. Rand as Treasurer, which arrangement continued until the death of Mr. A. C. Rand in March, which left the chief office vacant, when Mr. J. R. Rand was elected to the position. From small beginnings this business has developed into an important industry. When the Messrs. Rand became interested in rock drills, they were in the pioneer stage, with—apparently—a small and uncertain future before them, but they have come to be an essential part of every mining outfit. Rock drills were among the first American machinery products to find recognition among foreign engineers, and they are to-day at work in nearly every country on the globe where the mining industry has passed beyond the most primitive stage.

In 1873 Mr. Rand removed his residence to Montclair, N. J., where he had ever been prominent in local affairs. For three years he served on the Town Council; was for two years a chosen freeholder of Essex County; a charter member and first President of the Montclair Club, serving also another term; for fifteen years he was a trustee of the Congregational Church. He was one of the organizers of the Bank of Montclair, of which he was continuously the President. He was a member of the New England Society, the Hardware Club and Engineers' Club of New York City, and for forty years a member of the Mt. Moriah Masonic Lodge of Westfield, Mass.

He was practically acquainted with every field of business life from that of traveling salesman up. He had a remarkable fund of wit and of pointed but stingless repartee, which made him the most delightful of companions—qualities which naturally brought him friends without limit. These and other qualities also made him a presiding officer under whose gavel it was a delight to sit. He was interested in all public enterprises and contributed generously to their support.

He leaves a widow, a daughter and a son, the latter now representing the Rand Drill Company in Paris.

THE STOREHOUSE.

Methods of handling storehouse stock touch the economical operation of railroads very closely. Mr. John M. Taylor, General Storekeeper of the Illinois Central, said before the Western Railway Club last month that the delay in handling requisitions and the uncertainty of getting material were responsible for a large proportion of the money that is tied up in storehouse stock. He recommended telephone connection between the storehouse and all of the shop departments, with a system whereby an operator at the exchange could take orders from the shops for material and have the required number of boys under his direction to get the orders, have them filled, and deliver the required stores without involving the loss of time of expensive men in coming to the storehouse.

A comparison of the different shops on a large system on the basis of the proportion of the total value of stock issued

each month, was recommended as a good way to keep the department up in efficiency. A record of the total value of stock in each storehouse and the percentage handled during the month, showed at a glance the amount of dead stock, and such a plan was found advantageous in putting storehouses upon a commercial basis. The storehouse distributing 60 per cent. of its stock each month showed at once the superiority of its management over the one handling but 15 per cent. As in a mercantile establishment, the one in which the stock is "turned over" the greatest number of times in a year is the one to get the greatest benefits from its investment.

Price books and record books of all kinds are recommended very freely by writers on subjects of this kind. It seems strange that the advantages of the card catalogue system have been so slow in coming before those who are keeping complex railroad records. The price book or record book of any kind is at once at a disadvantage because of being a book. If the records are kept on cards, changes and renewals or substitutions may be made at any time without the serious inconvenience of re-writing the entire record when this becomes necessary because the book is full. Cards, kept in a suitable case, are as a general principle to be considered as not only more convenient but much more flexible in a record system.

Mr. Taylor has mentioned one of the important, but often neglected, factors of good shop as well as storehouse practice, light. He says: "The storehouse should have good light. Dark corners result in storing material out of sight, an expensive practice. All material that can be so accommodated should be carried on shelving, divided off into compartments of suitable size."

RELATIVE STRENGTHS OF IRON JAWS.

Malleable and Wrought Iron.

A comparison of the ultimate tensile strengths of wrought-iron and malleable-iron jaws used in interlocking signal work was recently made at the laboratory of the Massachusetts Institute of Technology. The tests were made for the Union Switch and Signal Company in connection with the extensive electro-pneumatic switch and signal installation at the new South Terminal Station in Boston.

The wrought-iron jaws were made in the usual form, Fig. 1,

Fg 1.

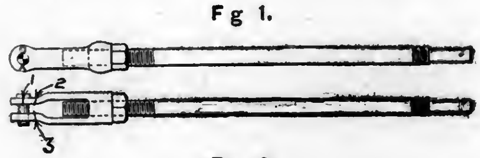


Fig. 2.

of round iron, of the size of 1-inch pipe, and fitted at the ends opposite to the jaws for the usual screwed and riveted connection to the 1-inch pipe which is used for working the switches. The malleable jaws are known as "screw jaws," because they are threaded upon the ends of the rods. They are employed where small adjustments in the length of the connections are necessary.

General opinion has favored the solid wrought-iron jaws as being stronger than the malleable-iron screw jaw, but these tests, instead of confirming this, point in the opposite direction, and indicate that the malleable screw jaws are much stronger than those of wrought iron. Three specimens of each form were tested. The wrought jaws of Fig. 1 broke at the point indicated in the sketch, two of them breaking in front of the pin and the other at the side of the pin. The average strength of these was 23,317 pounds, and the variation was not large in the three cases. The malleable jaws of Fig. 2 broke at the points, 1, 2 and 3, only one being at the pin. Breaks 2 and 3 were in the bends of the shanks, indicating that greater strength might be expected from an improved form at these points. The malleable jaws gave an average of 32,443 pounds, which is 9,126 pounds more than the figure for those of wrought iron. These figures are higher than the strength of the usual screwed and riveted pipe connections, which were also investigated in these tests. Three of the connections between the jaws and the pipes to which they were joined gave an average strength of 26,010 pounds, which indicates that the malleable jaws are superior and the wrought jaws inferior to the pipe joints in strength. The sections of the jaws of both kinds are of approximately the same area at corresponding points, which reduces the comparison of the jaws to a question between wrought and malleable iron as a material for such purposes.

These figures are interesting in their bearing upon the use of malleable iron in connection with air-brake rods and forks.

THE PURCHASING AGENT AND SPECIFICATIONS.

The place of the Purchasing Agent in railroad organizations was suggestively discussed by Mr. Ira C. Hubbell in a paper read before the Western Railway Club in March, in which he expressed hearty sympathy with the idea that the purchasing department should not be considered as a separate and distinct institution, but rather as a co-operative branch of each of the three great departments to which the operation of the modern railroad is intrusted, and that the Purchasing Agent should be, ex-officio, a member of each of them, as an expert in his particular line.

Mr. F. A. Delano had found closeness of touch with the purchasing department of great value, and thought it a mistake to locate the offices of the mechanical and purchasing departments miles apart, as was true of many roads. The two departments should co-operate, and the Purchasing Agent should be taken into the confidence of the Superintendent of Motive Power. The Purchasing Agent should attend the meetings at which the mechanical men discuss the needs of the department. All this indicates the desirability of breaking down the sharp department lines of the past for the sake of harmony, in which there is much to be gained.

In discussing the subject of specifications, Mr. F. W. Sargent stated that he had received specifications calling for a test bar on steel castings, where the test bar was longer than the castings.

Iron which is suitable for staybolts on one road is equally suitable for another, and yet nearly every road has its own specifications. Some of the requirements may be met at moderate cost, while others involve unnecessary expense. It seems entirely practicable to adopt standard specifications for many kinds of material, and the advantages would soon be apparent in the prices. This seems to be a wise and practicable idea.

The oil engine, says "Engineering," is rapidly settling down to one pattern, the variations being in the working of the valves and small matters of that kind, and not in matters of principle. In commenting upon the recent exhibition at York, England, it was said that the expiration of the Otto patents allowed all makers to adopt one design and there was no longer any demand on their ingenuity in evading its claims. At this exhibition special attention has been noticed with reference to lubrication, brushes being provided to catch the overflow of oil from the crankshaft bearings so that none could be lost. One of the large engines was fitted with a self-starter. This comprises a hand pump fitted alongside the cylinder. In using it, the exhaust valve is first propped open and combustible mixture is pumped into the cylinder until all the air is expelled. The valve is then closed and a further supply of combustible mixture pumped in. A valve at the top of the ignition tube is then opened, and the mixture flows up the incandescent tube until it fires and explodes the charge. The engine then gets away, and the ordinary cycle is taken up.

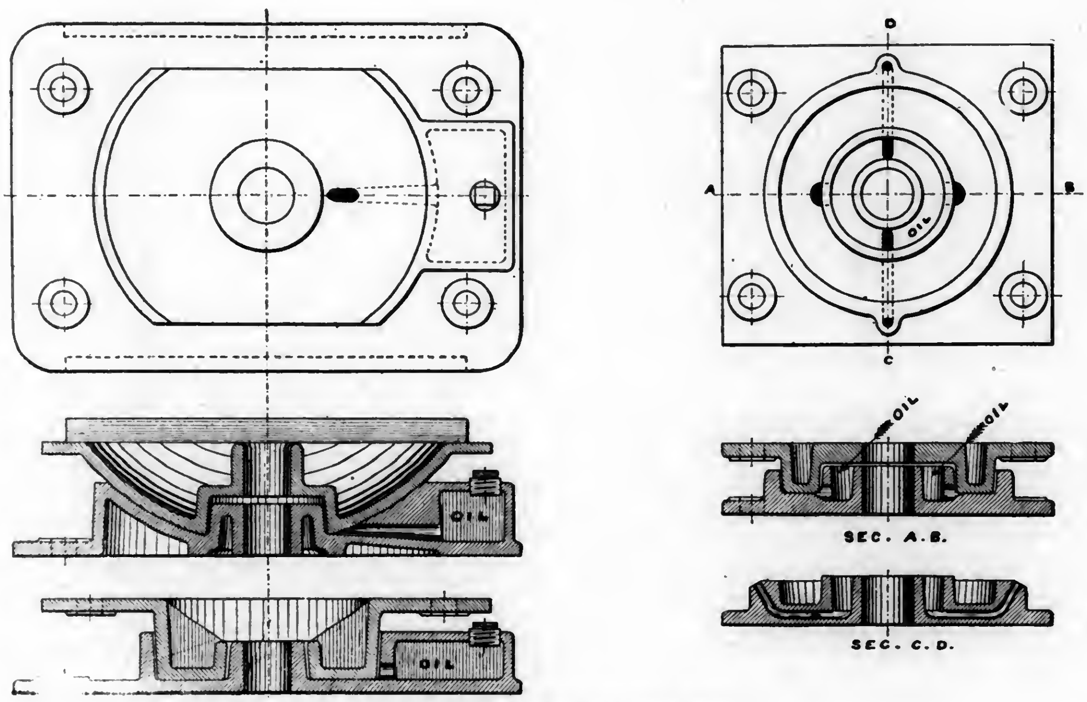
THE DAYTON LUBRICATING CENTER PLATE.

The necessity of lubrication of center plates was a prominent feature of the report upon this subject at the recent convention of the M. C. B. Association, several forms of lubricated center plates having been illustrated in the committee report upon this subject. Among them was the Dayton lubricating center plate, manufactured by the Dayton Malleable Iron Company under the patent owned by them. The name of the manufacturers, however, was not given in the report.

Our engravings show the construction of this center plate, which provides an oil pocket in the lower plate to keep the wearing surfaces constantly flooded with oil. It is made of malleable iron and the chamber is provided with a screw plug which may be removed for the addition of oil while the truck is under the car. This method of lubrication will greatly reduce the friction between the plates and its effect upon the wear of wheel flanges and the resistance of trains is exceedingly important.

A test was made in the warehouse of this company for determining the comparative resistance between dry and lubricated center plates. Service conditions were, as far as practical, duplicated; but it is not claimed that exactly the same results were obtained as are given by regular service. The plates used were taken from stock, and were not finished nor treated in any way, but used exactly as they came from the rattlers. The lower plate was secured firmly by bolts to the floor, and the upper one to a platform 8 ft. 6 ins. square, the plates being engaged as in service with the exception of the king bolt, or center pin, which was not inserted. Castings to the aggregate weight of 20,000 pounds were loaded on the platform and distributed to keep the platform balanced and bring all the weight on the center plates.

The platform containing the load was revolved by means of a windlass, a pointer being attached to one corner, and the movement was sufficient to cause this pointer to travel through an arc 6 ins. in length. The movement was effected by means of a tackle block attached to the platform at a point directly above that where the flange of the wheel would come in contact with the rail. The other end of the tackle block was attached to one arm of a bell crank, and the other arm of this crank rested on an ordinary pair of platform scales. The pivot of the bell crank was secured to one of the posts of the warehouse, and the tackle block was pulled by means of a windlass in order to give a continued, regular movement. The first load weighed was 2,000 pounds, and readings were taken as each additional 1,000 pounds were applied up to an aggregate weight of 20,000. The test was in this way made, first, with dry plates; the load was then entirely removed, the platform lifted, and the lower plate and oil chamber filled with oil, after which the test was repeated under exactly similar conditions and with duplicate weights. It will be noted from the figures that, as the travel of the platform increased, a greater amount of pull was acquired for turning it. This is owing to the fact that the angle of the pull increased as the platform revolved. It was found that the amount of pull depended largely on the speed at which the movement was made, and in making all tests this movement was made at as slow a speed as possible. With heavier weights—that is, above 12,000 pounds—readings were taken at each inch of the movement of the platform.



The Dayton Lubricating Center Plate.

From a large number of readings the following are reproduced:

Pounds Pull Required to Turn the Platform.

Weight.	Dry.	Lubricated.
2,000	150 to 225	40 to 47
15,000	600	155
20,000 to start	850	200
20,000	1 in. travel 900	210
20,000	2 in. travel 1,000	275
20,000	3 in. travel 1,035	235
20,000	4 in. travel 1,085	245
20,000	5 in. travel 1,125	265
20,000	6 in. travel 1,200	275

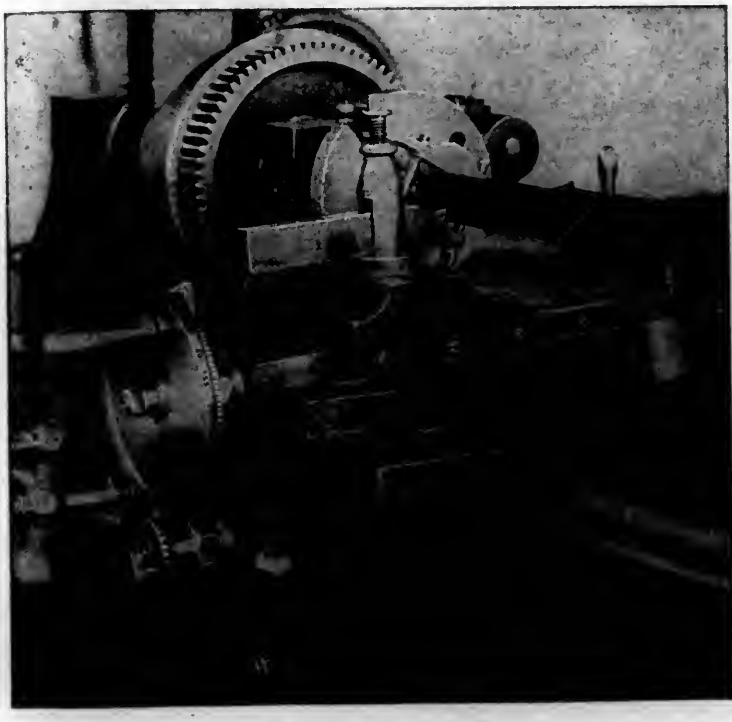
From these figures it appears that the frictional resistances of these lubricated center plates are less than one-fourth of those of dry plates.

"The oil and not the pigment of paint," says a well-informed correspondent, "measures the life of paint, although some high authorities hold to the contrary, I believe. The pigment should be considered as the boards of a fence and the oil as the nails. Then as soon as the weather rusts out the nails the boards fall off. In a similar way the weather eats out the gum and the life of the oil, and off comes the pigment."

GRADUATED DIALS ON LATHE CROSS SCREWS.

A great deal of money may be saved in machine shops by a relatively small investment in micrometer calipers together with graduated dials on the cross screws of machine tools. J. T. Slocomb & Company, manufacturers of micrometers, Providence, R. I., have used dials, as illustrated in the accompanying engaving, for a number of years and the idea seems to us excellent. They do not make them, but strongly advocate their use. They are not expensive and they certainly save time, labor and spoiled work. Several makers put these dials on their lathes, but they are usually too small in diameter and the graduations are too fine. At the shops referred to the discs are fitted in the place of the usual ball crank. A straight fit is turned on the quill extending from the lathe apron, and the pointer, which is split and held by a binding screw, is fitted to it.

They permit of turning sizes for accurate fits by the most



Graduated Dials on Lathes.

direct methods possible and without the usual "cut and try" process. The work is simply rounded up and measured with the micrometer, which shows how many thousandths are to come off; then, by the reading on the dial, the cutting tool is adjusted to take off the exact amount desired, with little chance for mistake and securing a great saving of time. These people say that any machinist of ordinary ability will never give them up when he has employed them long enough to become used to them. J. T. Slocomb & Company manufacture calipers for all-around machine shop work and they recommend them in place of all other outside gauges for work that is at all close. These micrometer calipers used in connection with the micrometer dials fill two "long-felt wants"; first, an accurate method of measuring work, and second, an accurate way for adjusting cutting tools in accordance with these measurements.

Although the most valuable feature of the dials is in adjustment for sizes, they have other uses. These manufacturers use them instead of the usual screw-cutting stop in cutting screw threads. This permits of accurately gauging the depths of cuts and avoids the troublesome springing of most screw-cutting stops, which renders it difficult to take fine finishing cuts. With the dial a 7/16-in., 14-thread screw on short work, is started with five 0.005-in. cuts, followed by six cuts of 0.003 in. and finished by a cut of 0.001 or 0.002 in. All guessing is avoided and the work is very easily duplicated for any desired number of pieces. Taper turning is equally simplified by this attachment and the dial may also be used for measuring the extent to which work is "out of true," and for measuring cuts on inside work in places difficult of access.

It is evident that judgment and experience are required in handling such work, and the lack of accuracy of most feed screws must be guarded against. The variations often amount to 0.006 in. in the length of a screw, but this will cause no trouble with short work. These people say that the dials are somewhat confusing at first, but, speaking from experience, they find that it does not take long to become accustomed to them. The dial must, of course, be graduated to fit the pitch of the feed screw. For an 8 P. screw they use dials 5 in. in diameter, graduated in 125 divisions by short lines for thousandths and every fifth line extended and numbered. One division on the pointer is graduated to quarter thousandths. One division therefore reduces the diameter one-half thousandth.

THE "DEUTSCHLAND."

The twin-screw steamship "Deutschland" of the Hamburg-American Line made on her maiden trip an average of 22.42 knots per hour for 3,044 knots from Plymouth to Sandy Hook, arriving in New York July 12. Her daily runs were 308, 557, 553, 551, 532 and 543 knots, making the trip in 5 days, 16 hours and 15 minutes, which beats the best previous record of western trips. On the return trip another new record was made to Plymouth in 5 days, 14 hours and 6 minutes, the average speed being 23 knots.

By courtesy of Mr. Emil L. Boas, General Manager of the line, the ship was opened to visitors in New York. In appearance the "Deutschland" resembles the "Kaiser Wilhelm der Grosse," but is longer by 38 ft., and has 7,000 more indicated horse-power. The "Deutschland" is 686½ ft. long, her breadth being 67½ ft. and depth 44 ft., and displacement 16,000 tons. The engines are in two sets, quadruple expansion, with six cylinders each. The indicated horse-power is 35,000. There are 12 double and 4 single boilers, having 112 furnaces. Her propellers are 23 ft. in diameter. She has six decks, 17 water-tight compartments, and a double bottom divided into 24 chambers. She has accommodations for 467 first class, 300 second class and 300 steerage passengers. A large play room for children, and gymnasium on the promenade deck, are available to first class passengers, and a grill room upon the boat deck, open until midnight. The promenade deck is 520 ft. long. The ship has bilge keels and her appointments throughout leave nothing to be desired for comfort and convenience.

NELS YELLOW SIGNAL LIGHTS, C. C. C. & ST. L. RY.

The Superintendent of Telegraph of the "Big Four," Mr. C. S. Rhoads, writes of his experience with Mr. John C. Baird's new glass in signals in strongly favorable terms. In a recent test made on the open road, away from the view of conflicting city lights, he found that he could get a good view of the red at a distance of two miles. The green was also clear at that distance and, he thinks, slightly clearer than the red. The yellow glass, however, gave a distinct indication at a distance of three miles. Mr. Rhoads says: "The more I see of the yellow, the better I am pleased with the change we have made in connection with the green as a clear signal. Our system is being changed to conform to the new standard, taking one division at a time."

It is pleasing to see such confirmation of the opinion of this yellow glass, which this journal has repeatedly expressed. The question of the color of signal lights has not received much attention from motive power officers, but if they interest themselves in it they will not only contribute important assistance, but will find it a subject in which they are very directly concerned, viz., one which has to do with the loss of time of trains. It would help the reform in signal lights if the mechanical department officers should consider this subject before the railroad clubs. They really know more about the requirements of signal lights than anyone else. The cost of running fast trains is so great as to warrant consideration of every question tending toward the certainty of signal indications.

"DIAMOND S" BRAKE SHOES AT PARIS EXPOSITION.

Appreciation of "Diamond S" brake shoes is not confined to the railroads using them in the United States, but it has extended to roads in all parts of the world. The exhibit at Paris, which is shown in the accompanying engraving, is in charge of the Paris representative of the company, Mr. Rochette. The exhibit consists of new and worn "Diamond S" brake shoes with bundles of expanded metal and records in the form of tables and diagrams showing the performance and the effect of the shoes upon tires. The enclosure of the exhibit is a network of expanded brass in a framework of wrought iron. The arch at the top of the front of the booth represents a section of a tire with a brake shoe in position. Altogether the exhibit is

The International Brake Shoe Co. Paris Exposition.

an attractive one, and its prominent position in the midst of the locomotive exhibit brings it to the attention of all interested in railway appliances. The patents on this brake shoe, outside of the United States, are controlled by the International Brake Shoe Company. This concern is now supplying brake shoes to railways in England, France, Italy, Russia, Turkey, India, South Africa, Central and South America, Mexico, Canada and other countries. The president of the company, Mr. W. D. Sargent, recently returned from a very successful trip abroad. We are informed that the International Brake Shoe Co. has been awarded the silver medal, which is the highest award given this class of appliances at the Paris Exposition.

RAILROAD ROLLING EQUIPMENT IN THE UNITED STATES.

According to the figures of the Interstate Commerce Commission there were 36,703 locomotives in the service of the railways on June 30, 1899, or 469 more than the year previous. Of the total number reported, 9,894 are classed as passenger locomotives, 20,728 as freight locomotives, 5,480 as switching locomotives, and 601 are not classified.

The total number of cars of all classes in the service of the railways on June 30, 1899, was 1,375,916, an increase of 49,742 being shown in this item. Of the total number, 33,850 are assigned to the passenger service, 1,295,510 to the freight service, and 46,556 to the direct service of railways. It should be understood, however, that cars owned by private companies and firms used by railways are not included in the returns made to the commission. The report under review contains summaries intended to indicate the density of equipment and the extent to which it is used. It appears that the railways of the United States used on the average 20 locomotives and 734 cars per 100 miles of line; that 52,878 passengers were carried, and 1,474,765 pasenger-miles accomplished, per passenger locomotive; and that 46,303 tons of freight were carried and 5,966,193 ton-miles accomplished per freight locomotive. All of these items show an increase when compared with corresponding items for the preceding year ending June 30, 1898. There was also a decrease in the number of passenger cars per 1,000,000 passengers carried, and a decrease in the number of freight cars per 1,000,000 tons of freight carried.

Both locomotives and cars being embraced in the term equipment, it is observed that the total equipment of the railways on June 30, 1899, was 1,412,619. Of this number 808,074 were fitted with train brakes, the increase being 166,812, and 1,137,719 were fitted with automatic couplers, the increase in this item being 228,145.

Practically all locomotives and cars in the passenger service were fitteu with train brakes, and of 9,894 locomotives assigned to that service 6,128 were fitted with automatic couplers. Nearly all passenger cars were fitted with automatic couplers. With respect to freight equipment, it is noted that nearly all freight locomotives were equipped with train brakes and 45 per cent. of them with automatic couplers. Of 1,295,510 cars in the freight service on June 30, 1899, 730,670 were fitted with train brakes and 1,067,338 with automatic couplers.

A GRACEFUL ACKNOWLEDGMENT.

Mr. Bowen R. Church, leader of Reeves' Band, who furnished the delightful music at the recent convention at Saratoga, was presented with a fitting testimonial after the adjournment of the conventions and the presentation was made in the following letter, which was signed by the presidents of both associations and the committee of the Supply Men's Association:

"The members of the Master Car Builders', American Railway Master Mechanics' and Railway Supply Men's Associations, represented at the Saratoga Convention held in June, 1900, as a token of their appreciation of your willingness in the past to give them individually, as far as in your power, any selections they desired, and for your efforts at all times to please them and their guests, present to you this diamond ring, the brilliancy of the stone being only eclipsed by the delightful music furnished by you and your band. We hope that long life may be given you to enable you to wear this memento for many years to come."

BOOKS AND PAMPHLETS.

Railroad Operations: How to Know Them. From a Study of the Accounts and Statistics. By J. Shirley Eaton, Statistician of the Lehigh Valley Railroad. New York: The Railroad Gazette, 1900. Price, $2.00.

This book was intended specially for managers, investors, students and railway experts. It is written from the standpoint of an expert who is a close student of railroad statistics and one thoroughly informed upon his subject. There are few books in this field, and the great and increasing importance of properly prepared statistics renders such a work particularly appropriate. The recent years of business depression have induced close watching of every department for the discovery of possibilities for saving. The discussion in the press and among railroad men, of particularly interesting annual reports, was never so common before, and we take this as an indication that railroad methods will be more closely studied and carefully com-

pared as the number of opportunities for saving decrease. We should say that Mr. Eaton has written also for the department officers because a careful examination of the book will suggest many improvements to many officers, such as the chief engineer, division superintendent and superintendent of motive power. The author treats not only of dry figures, but offers many sensible suggestions. Under "Reducing Expenses" he says: "The order is 'retrench.' It comes as an emergency, with no time to parley. It follows that much retrenchment lacks method. Sometimes they adopt a rule of cutting requisitions in two. A master mechanic needs just 60 feet of belt for his shop engine and the manager reasons that for economy he must cut the requisition in two, and the shop is delayed for 30 feet of belting." Managers do more foolish things than this. Such retrenchment as adding two more cars per train, reducing train mileage and increasing net earnings is advocated. Many of the ideas concerning management are old, but no one can glance through the book without being instructed or reminded as to possible improvements. It will be seen by the following list of chapters that the author is more than a statistician: Hints for Examining Railroad Property; Watching Freight Traffic Currently; Expenses; Passenger Traffic; Reducing Expenses; Examining Earnings; Car, Engine and Train Movement Statistics; General Principles of Interstate Commerce; Classification of Expenses; Maintenance of Way Expenses; Maintenance of Equipment; Conducting Transportation; General Expense; Public Statistics; Operating Units; Averages; Prorating; Railroad Statistics; Expense Classification; The Earning Classification; Working Tools for the Statistician; What is Cost? Capital and the Fundamental Theory of a Railroad.

We approve the author's arrangement of putting the historical at the end. It is the least important part of the work, but is not without interest and value. To the reviewer the fundamental ideas of the author seem to be two: 1, To show the principles of railroad statistics. 2. To show how they may be used currently by the men in charge of operation, to obtain better results. The frequent use of the word "current" indicates a broad idea of what statistics are for, not alone for the investor, but for the operator, and to us the latter use is of the more vital importance to the owners of the property. It is evident that the author advocates the use of figures by the various division superintendents for the comparison of their work month by month and of that of other divisions.

A high place is given to the ton-mile unit, which Mr. Eaton considers the best single unit thus far offered, but it is shown to be necessary to have other units also. We find the book much more interesting and a great deal more valuable than the title seemed to indicate. It should be read by every manager, superintendent, motive power officer and purchasing agent.

Railway Signaling. By H. Raynor Wilson, of the Lancashire & Yorkshire Railway, England. Published by the Publishers of "The Railway Engineer," 8 Catherine Street, Strand, London, England, 1900. Price (in England), 18 shillings.

This long-promised book has appeared in greater part in the columns of "The Railway Engineer," and it is now brought up to date and enlarged. The author desired to prepare a standard work covering the entire subject of railway signaling, but the phenomenal growth and development of the electric side of the subject necessitated separate treatment, the work before us being confined to mechanical apparatus. The author has confined himself to apparatus which represents sound practice in England, and we nowhere find the appearance of a desire to merely record experiments. The work is divided into the following chapters: Single Lines; Signal Cabins; Wood and Iron Posts; Point and Signal Connections; Locking Frames; Signaling plans; Level Crossings; Examples of Large Signaling Installations; Board of Trade Requirements and standard specifications for signaling works. The author is a master of his subject and has used excellent judgment in the plan and execution of the work. Giving due regard to the historical, he gets at once into present-day questions and in this he is especially to be commended. He presents the principles and details of English methods and gives working drawings of everything used about mechanical interlocking except those devices which must be bought from the manufacturers, such as train staff apparatus. Every signal engineer and operating officer should secure a copy of this book, because of the large number of suggestions which may be obtained from such a thorough record of English practice, and because of the opinions of the author on many points of practice. The book is altogether the best that has ever appeared on the subject of signaling, and not the least valuable features are the Board of Trade requirements brought up to date, and a reproduction in full of the standard signal specifications of the Great Eastern Railway. The book contains a number of large folded plates of signal and switch plans for such terminals as the Waverley Station, Edinburgh; the Liverpool Street station of the Great Eastern Ry., and the Waterloo terminus of the London & Southwestern. From correspondence with the author and in other ways our expectations concerning this work have been high and the result is not in any way disappointing.

Standard Designs for Boats of the United States Navy. Specifications, Schedules of Material, Weights and Cost. By Chief Constructor Philip Hichborn, U. S. N., Chief of Bureau of Construction and Repair, Navy Department, Washington, D. C. Government Printing Office, 1900.

The standard navy boats have been evolved from experience and careful study of the special conditions to be met in the naval service, and the excellent work before us is a complete record of the present construction, even to the speed trials of the various steam launches. Each boat is represented by working drawings, shear, half breadth and body plans, specifications, bills of material, weights and actual costs. For completeness, arrangement and excellence of execution this book has not often been surpassed, and the impression of conscientious thoroughness in design of these boats is at once received. It is evident that the navy department has made good use of the New Bedford whaleboat in its designs for boats of relatively light carrying capacity, and the models for launches of large capacity have been worked out with equal care. The volume is in every way creditable, and the half-tones of complete boats are unusually fine. We cannot see how anyone can help being stirred with admiration for the 30-foot gig whaleboat of Plate 159, which is one of many illustrated. Such work as this in a relatively small matter connected with a war vessel increases the confidence that our naval interests are in the hands of the right kind of men.

American Railway Association. Proceedings Covering the Period from 1894 to 1898, Inclusive. Published by the Association, 24 Park Place, New York, N. Y. Price, $5.00.

This is the second volume of the proceedings of this Association and the records of its important work from the beginning up to and including the convention of 1898 are now available in a form which is convenient for reference and preservation. To our readers it is not necessary to say anything about the value of these volumes, but we take this opportunity to direct attention to the great amount of work which the secretary of the Association, Mr. W. F. Allen, has done to put the proceedings into this form, and to compliment him upon the character of the presentation.

Mechanical Equipment of the New South Station, Boston. By Walter C. Kerr. A reprint of a paper read before the American Society of Mechanical Engineers, December, 1899.

This paper is unique and very valuable. We have already referred to it in our columns. It presents a description by the contracting engineers of the interesting work connected with the design and installation of the mechanical equipment of the largest railroad station in the world. The variety of the work and its extent, together with the exceedingly exacting conditions, render it worthy of study by many who are not specially engaged in station work, because the various factors in this aggregation are sufficiently extensive to compare with installations for towns of considerable size. This is specially applicable to the lighting problems. There are twelve separate branches of engineering represented in this undertaking, all of which was intrusted to Messrs. Westinghouse, Church, Kerr & Company. These are as follows: 1. Power-house. 2. Interlocking switch and signal system. 3. The electric plant. 4. Heating and ventilating. 5. Disposal of drainage from waterproofed structure. 6. Roof drainage. 7. Ice-making, refrigerating and water-cooling plants. 8. Car heating in train shed and yards. 9. Air-brake charging. 10. Steam and hot water supply to head-house. 11. Fire protection. 12. Elevators, baggage and express lifts. The entire work was handled as a unit, and this is to us its most interesting feature, as it is a departure from the usual practice of calling in a number of

experts in the various branches of engineering represented and giving them commissions to work independently. In this case the responsibility was concentrated and the work was not only better done, but a great deal of money was saved. The fact that a single firm is prepared to conduct such an enterprise is significant of the high place which Westinghouse, Church, Kerr & Company have attained. Such a paper as this should be placed in the hands of investors and others who are responsible for the large railroad terminals of this country. Copies may be had from the Westinghouse Companies Publishing Department, Pittsburg, Pa.

Traveling Engineers' Association. Proceedings of the Seventh Annual Convention, Held at Cincinnati, Ohio, September, 1899. Edited by the Secretary, Mr. W. O. Thompson, Elkhart, Ind.

The annual volume of proceedings of this energetic Association contains the record of the last convention and discussions of the following subjects: "The use of water on hot bearings of locomotives and tenders;" "How can the responsible engineer be located when an engine has been subjected to unfair usage under the pooling system?" "The proper care of the air pump and engineer's valve while in service, and what is essential to the successful handling of air brake trains;" "In employing or recommending young men for firemen, what qualifications should they possess?" "Long runs of locomotives, with a view of economical treatment, and maintenance;" "Is it economy to use the exhaust steam from the air pump to heat the feed water?" "Eyesight tests;" "Boiler compounds and purges."

"The Foundry" for June, 1900, contains an admirable article by Paul Weaver upon brass furnaces, which we commend to our readers who are using the familiar "hole in the ground" method of melting brass. The author states a strong case for improved furnaces as to economy of fuel, and also in the service of crucibles. "The Foundry" is published at Detroit, Mich.

Among the special features of the July Magazine Number of The Outlook will be found a collection of portraits and pictures relating to the present Chinese crisis, including several never heretofore printed, and of unusual interest; an article on the political career and character of Joseph Chamberlain by Mr. Justin McCarthy, the author of "The History of Our Times" and "The Story of Gladstone's Life," with portrait; an account of a "Visit to the Prince of Montenegro," by E. A. Steiner, with many pictures; an elaborately illustrated article on Lourdes, "A Town of Modern Miracles," by Clifton Johnson, who furnishes also the photographs reproduced; an illustrated article on "The Religious Situation at Harvard," by Mr. Durant Drake; a singular story called "The First Judas," by Florence M. Kingsley, whose novel of early Christian times called "Titus" achieved such an extraordinary success; another instalment of Mr. Hamilton W. Mabie's series of illustrated articles on Shakespeare, and several other illustrated and unillustrated magazine articles, together with the usual full historical review of the world, editorials and other departments. ($3 a year. The Outlook Company, New York.)

Pneumatic Tools, 1900. The Q & C Company have issued a new 50-page pamphlet on the subject of their pneumatic tools, including hammers, drills, riveters, stone-cutting hammers and flue expanders. The illustrations, which are very good, show the tools assembled and in groups of parts, each part being numbered for reference in ordering. This catalogue is specially commended for the clear and concise descriptions and the good engravings.

Westinghouse Friction Draft Gear. A pamphlet prepared in the usual admirable style of the Westinghouse companies presents an elaborately illustrated description of this interesting device. Our readers will remember the description on page 148 of our May number and in the pamphlet they will find not only a description, but transparent interior views of the gear, records of tests and a number of illustrations of methods of application of the draft gear to the framing of cars and tenders. The appearance of the pamphlet is opportune, because of the increase of interest in the subject by the increasing capacities of locomotives and cars. Readers are advised to secure copies from the Westinghouse Air Brake Company.

"Standard Steel Rails and Splice Bars Manufactured by Carnegie Steel Company, 1900," is the title of a handsome volume in flexible leather, containing all that engineers need for reference to the steel rails used on the railroads of this country. The rail sections of the various roads, tables of rails, splice bars, spikes, specifications of rails, and the names of the roads using each section are given. The dimensions are stated in metric and English units. In every way it is worthy of the Carnegie Steel Company. We have received a copy through the courtesy of Mr. A. R. Peacock, First Vice-President of the Company.

"Record of Recent Construction No. 19" of the Baldwin Locomotive Works contains a number of interesting designs, among which we note the H5 freight locomotive of the Pennsylvania; a heavy 10-wheel engine for the C. & O.; a compound consolidation for the Bavarian State Railways; a compound Atlantic type passenger engine for the Central of New Jersey, and a number of engines for home and foreign roads. The closing illustration in the pamphlet shows a small tank engine with 9 by 14 in. cylinders for Mr. Arthur Koppel. It is built for a 23⅝-in. gauge and weighs 25,550 lbs. The service includes curves of 59 to 66 ft. radius. These pamphlets are always in excellent taste and their value as a record of the work of the largest builders of locomotives is doubtless appreciated.

"Electric Train Lighting from the Car Axle." We have received from Mr. Jno. N. Abbott, Vice-President and General Manager of the Consolidated Railway Electric Lighting & Equipment Co., a copy of a handsome pamphlet bearing this title. The apparatus was described in our issue of December, 1899, page 400, except as to the method of driving the generator, which has been improved and simplified. The pamphlet presents in a number of fine engravings the adaptation of the system to coaches, mail and special officers' cars. This company also controls a system of refrigeration, making use of its axle-driven generators. Besides the excellence of the light, absolute safety from conflagration in case of wrecks is strongly urged for this system.

The Hayden & Derby Manufacturing Company, 85 Liberty Street, New York, have issued a new price list and catalogue, 44 pages, 6 x 9 in., dealing with the various types of Metropolitan Injectors and H. D. Ejectors of which they are the sole manufacturers. The catalogue is finely illustrated and has for a frontispiece an excellence view of the company's plant at Bridgeport, Conn., one of the most complete and modern establishments of its kind in the world. In addition to a detail description of the Metropolitan Automatic Injector, Metropolitan "1898" Injector, and Metropolitan Double-Tube Injector, the book contains much interesting information on the subject of injectors generally, with suggestions as to the proper type and size injectors for the most satisfactory and economical results. Special attention is directed to what these injectors will accomplish under various conditions. Copies of the catalogue may be obtained upon application to the Hayden & Derby Manufacturing Company, and they should prove of value to engineers and steam users for ready reference.

"Concerning Roller Side Bearings" is the title of one of the most attractive little pamphlets of its kind we have seen this year. It is issued by the Simplex Railway Appliance Company, Fisher Building, Chicago, and is devoted to the Susemihl side bearing. This device is the result of about 15 years' experimental work by Mr. F. G. Susemihl, of the Michigan Central R. R., and in its present form it has been used continuously for three years without developing defects. The arrangement of the rollers compels them to roll with the movements of the trucks and the rollers are kept out of contact with each other; furthermore, they cannot drop out of the bearings. When the car is jacked up from the trucks the parts of the bearing all go with the upper bearing, and they cannot fall out or become lost. The principles of the construction were illustrated on pages 339 and 394 of our October and December numbers, 1898, but several important improvements have been made since that time. At the recent Master Car Builders' convention the question of side bearings was considered one of the two most important subjects for discussion, because of the effect of side bearing friction upon the net hauling capacity of locomotives. It seems to be the general opinion among car men that if roller bearings can be so constructed that the rollers will not flatten in service they will be used because of the possibility which they offer of reducing the weight necessary to make the bolsters

sufficiently rigid to sustain their loads without deflection. We go further than this and believe that roller side bearings are necessary anyway, even with stiff bolsters, and the design referred to here seems to meet all requirements.

Metal Sawing Machine. The Q & C Company have issued a new catalogue of power sawing machines, portable rail and shop saws, in which attention is called to the fact that this company are the only manufacturers of cold metal saws of both the arbor and blade driven types. They are consequently in position to recommend whichever type seems from their experience to be best adapted to the purchaser's requirements. They also call attention to the arrangement of their power machines, which permits of cutting structural iron work in the positions which involve the least length of cut, which leads to a great economy in time. The portable rail saws and shop saws have been improved in many ways to increase their convenience and durability. These machines are illustrated in a large variety.

The passenger department of the New York Central has issued a folder on Bronx Park and the pilgrimage system of teaching. This gives complete directions for visiting the New York botanical gardens and museum, as well as the other features of the famous Bronx Park, and the other side of the folder is devoted to an itinerary for a trip through the country on the New York Central near New York, which is full of historical interest from its connection with the American Revolution. The number of short trips about New York and the actual knowledge of history, geography, geology, botany and (at the Bronx Park) zoology, which may be obtained in a short time and at a very small cost, is surprising. A copy of the folder will be sent on receipt of a postage stamp by Mr. Geo. H. Daniels, General Passenger Agent, New York Central Railroad, New York.

"The New Pennsylvania Limited" is described in a pamphlet which is unique and beautiful, published by Mr. E. A. Ford, General Passenger Agent of the Pennsylvania Railroad. The literature of the passenger and advertising departments of our best railroads has improved wonderfully during the past few years. It contains many examples of high art in printing and illustration, but it seems impossible to surpass this of the Pennsylvania. The cover is in the cream and olive-green colors of this train and the printing, engraving, paper and binding are finely executed. The illustrations are half-tones from photographs actually taken on this train, and they exhibit a degree of luxury and comfort equal to those of the best clubs and hotels. Copies may be obtained from the General Passenger Agent.

The White Mountains of New Hampshire are conspicuous in many ways. The region is one grand wonderland, and every turn brings the visitor to some attraction in which Nature's marvellous embellishments are displayed. The famed "Crawford Notch," "The Flume," "The Old Man," "Elephant's Head," "The Lake of the Clouds," the Gulf, the ravines and cascades are but a few of the many notable features with which it would seem this region has been so extravagantly endowed. One hardly realizes how imposing the mountain surroundings are until a visit has been paid them, but a slight idea of some of their principal attractions may be gained from perusing the "Mountain Hand-Book," issued by the Boston & Maine Railroad, and for pictorial views of the mountains the Boston & Maine portfolio known as "Mountains of New England," will prove interesting and instructive. The first mentioned book is sent for a two-cent stamp, the latter for six cents in stamps to any address upon application to the Passenger Department of the Boston & Maine Railroad, Causeway Street, Boston, Mass.

EQUIPMENT AND MANUFACTURING NOTES.

Mr. Jere Baxter of the Tennessee Central is in the East to buy equipment for that road. It is expected that he will place orders for about $500,000.

Owing to increased business, the Modoc Soap Company have found it necessary to enlarge their manufacturing facilities by moving into a new five-story brick building, No. 119 West Second street, Cincinnati, in which their capacity is greatly increased. This became necessary in order to meet the demands of railroads for Modoc Liquid Car Cleaner, which is used by nearly all the leading railroads of the country for cleaning passenger cars.

The International Power Company have just delivered ten 10-wheel compound locomotives to the Chicago Great Western Railway for passenger service. The parts made in cast steel are the driving wheels, driving boxes, link hangers, reverse shafts, low-pressure piston, rocker shafts and cross heads. They have Nathan lubricators, Ashton safety valves, Richardson valves, Westinghouse brakes, Sargent brakeshoes and Ajax bearings.

Through inadvertence we failed last month to refer to one of the most attractive exhibits at the recent Saratoga conventions—that of William Sellers & Company. Their locomotive injectors, new water strainer, boiler check and valve, and combination check and stop valve were exhibited and all of them attracted a great deal of attention and interest.

Lucol paint has been selected for use on the 1,200 high-sided coal cars which the Wheeling & Lake Erie are building at their Ironville shops. With this paint the cars are painted and stencilled, ready for the road, in twelve hours, which is a decided advantage over slow-drying paints under such circumstances. In a recent experiment with Lucol paint on this road, one of the new cars was sprayed at 7 a. m. At noon it was dry and was sprayed with a second coat. At 5 p. m. it was dry enough to stencil and at 6 p. m. it was in a train with a load of coal.

Mr. J. W. Duntley, president of the Chicago Pneumatic Tool Company, Chicago, Ill., who returned to Europe on the "Kaiser Wilhelm der Grosse," on July 3d, for an extended stay at the Paris Exposition, invites customers and friends of the company who visit the Exposition to call on him at their exhibit in the American Machinery Building, Vincennes, in Space 1, Block 9, or at the Palace of Machinery and Electricity, Champ de Mars, Space 1, Block 14, where he will be pleased to meet them and extend any courtesies that will be acceptable in looking up points of interest.

The Chicago Grain Door Company, Monadnock Building, Chicago, has received within the past 60 days the following orders for its grain door equipment:

"Soo" Line, 3,000 cars.
Northern Pacific, 1,000 cars.
Great Northern, 1,000 cars.
Chicago, Milwaukee & St. Paul, 1,000 cars.
Atchison, Topeka & Santa Fe, 500 cars.
Illinois Central, 2,500 cars.
Intercolonial Ry. of Canada, 1,100 cars.
Canadian Pacific of Canada, 1,200 cars.

It is safe to say that the most attractive exhibit at the recent M. C. B. and M. M. Association conventions was made by the Pintsch lighting people. Their display occupied a very prominent place, for it was located in the lobby of the Grand Union, while the other exhibits were to be found out in the court-yard and along the veranda. The framework upon which the various styles of Pintsch lamps were suspended was finished in white and gold, backed with heavy plate mirrors. The four styles of lamps shown thereon were all gold-plated and equipped with either cut glass bowls or bowls of chased glass with empire designs. A novel feature consisted of a dining car table spread with beautiful linen and fine napery and holding all the correct table appointments, highly polished silver, pretty tea service and beautiful china. Over this table extended a two-branch silver-plated gas candelabra showing how useful and effective an ornament it would be in dining cars. A white and gold screen afforded a display place for five or six styles of lamps for side illumination, which might be well employed by railroads of this country where they want novel effects in first-class coaches, parlor and dining cars. Some of the styles shown were a Roman torch design, a three-branch gold-plated candelabra and an argand bracket lamp. The beauties of this exhibit were enhanced by beautiful potted palms placed around the platform and a judicious use of Eastern rugs, while the chairs at the dining table and those to be used by visitors were of mahogany, handsomely designed and with leather seats. The light as usual was brilliant and the whole exhibit added greatly to the cheerfulness of that part of the Grand Union.

MASTER CAR BUILDERS' ASSOCIATION.

Thirty-fourth Annual Convention.

Abstracts of Reports.

(Concluded.)

TESTS OF MASTER CAR BUILDERS' COUPLERS.

Committee: W. W. Atterbury, W. S. Morris, W. P. Appleyard, H. Monkhouse, F. A. Delaho.

It will be remembered that at the last meeting of the Association, the general subject of the "Master Car Builders' Coupler" was considered of sufficient importance to warrant the appointment of a standing committee of five, the work of the committee to be somewhat of the character of your standing Committee on Brake Shoes and Triple Valves.

The work of your committee during the last year has been largely that of perfecting the details of the work submitted at the last meeting of the Association, and has, therefore, been as yet unable to do any work on the more serious question, that of the tests of the Master Car Builders' couplers.

Drop Testing Machine.

The drop testing machine which has been adopted as recommended practice has now been thoroughly developed and the detail drawings form a part of this report.

Subsequent to the last meeting of the Association, Purdue University, through Prof. R. A. Smart, with the approval of the late President Smart, and subject to the approval of its trustees, made a proposition to your committee to the effect that a drop testing machine, of the design approved by your committee, be constructed by the university at its expense, under the direction of your committee; that such machine, when built, shall be the property of Purdue University, and shall be installed in its laboratory, to be at all times subject to the use of the Master Car Builders' Association, through its proper committee, for official research, the university to furnish such aid and assistance and subsidiary apparatus as may be convenient; the machine to be at all times usable by Purdue University for educational and commercial purposes; all of the above to apply to any improvements in the machine which may be devised by your committee.

The Association will note that the conditions are practically those under which the Master Car Builders' Brake Shoe and Air-Brake plants have been installed, except that in this case the plant would be the property of the university.

Your committee submitted the proposition to the Executive Committee and was by it empowered to act in the matter, and has, therefore, believing the proposition to be exceedingly fair, taken it up with Purdue University, and is now awaiting advice of the favorable action by the trustees of that institution.

Your committee hopes that before the next meeting of the Association this drop testing machine will be constructed and in operation and some definite results obtained from the same.

Worn Coupler Gauge.

The secretary of the Association was authorized, and has arranged with the Pratt & Whitney Company, of Hartford, Connecticut, to manufacture this gauge, and your committee is advised that at the present time 241 of these gauges are under process of construction.

Coupler Contour Gauge.

This gauge, which was somewhat modified, with the approval of the Association at its last meeting, is now being manufactured by the Pratt & Whitney Company, and the members of the Association should be able to obtain them on order.

Twist Gauge.

The twist gauge, as approved as "recommended practice" at the last meeting of the Association, has been in use experimentally by your committee for some little time, and some slight changes and modifications have been found necessary. Your committee does not feel warranted, as yet, in placing this gauge in the hands of a manufacturer, as there is a possibility that a more extended trial will demonstrate that some further changes may be required.

Marking of Master Car Builders' Couplers.

In view of the fact that some couplers are bought on time specifications, it has been suggested that a method of marking similar to that now in general use on air-brake hose be adopted for couplers.

In the event of the proposed method meeting the approval of the Association, your committee would further recommend that it be embodied in the specifications and the same changed to read as follows:

"The name of the coupler and class of bar must be cast on the top side of head of bar in letters and figures three-fourths inch long and raised one-sixteenth inch. Each drawbar must also have plainly cast upon it the Master Car Builders' standard label of dimensions and size, and in the location as shown in detail on drawing which forms a part of these specifications. Each knuckle must," etc.

Increased Dimensions of Shank of Coupler.

Your committee has given this subject considerable thought, but is not at present prepared to recommend an increase in the dimensions of the shank of the coupler, in view of the fact that such radical changes as the committee would desire to make will necessitate very material changes in such standards of the Association as pertain to the spacing of center sills, location and dimensions of draft timbers, etc.

It is possible that the development of the metal center-sill or metal draft-timber may bring about such a design of these parts as will permit the use of a coupler with an increased shank. Before this matter can be definitely settled it may require a joint meeting of your standing Committee on Couplers and your Committee on Draft Gear.

Master Car Builders' Coupler Knuckle.

As the interstate commerce law in regard to the use of automatic couplers becomes operative on August 1, 1900, the necessity for the link and pin disappears. Your committee believing, therefore, that the time for the abandonment of the link-pin hole and slot is now at hand, hereby ask for such discussion of the subject as will enable your committee to intelligently make its recommendations.

DRAFT GEAR.

Committee: J. R. Slack, James Macbeth, W. E. Sharp.

In order to obtain information as to the practice and experience of the various roads in regard to draft gear, circulars containing 16 well-directed questions were sent to the members of the Master Car Builders' Association.

For convenience the different forms of draft gear used have been divided into classes, which are designated as follows:

A.—One double-coil spring with cast-iron stops bolted to wooden draft timbers. This is the ordinary form of Master Car Builders' recommended practice.

B.—Twin springs with malleable-iron cheek pieces or draft arms bolted to wooden draft timbers.

B^1.—Twin springs side by side, with malleable-iron draft arms bolted to the sills of car.

C.—Twin springs placed side by side, with malleable-iron cheek pieces bolted to wooden draft timbers.

D.—One double-coil spring, as in type A, but with pressed steel or malleable-iron stops.

E.—One double coil spring with malleable-iron cheek pieces or draft arms bolted to wooden draft timbers. In this type, as in type B, the front and back stops are in one piece with the draft arms, so that the pulling and buffing strains are distributed among all the bolts holding the draft arms, instead of the bolts holding each stop acting separately, as in types A and D.

F.—Draft rigging of the Graham type.

G.—Draft rigging of the American continuous type.

H.—Four two-coil springs arranged side by side in tandem.

The number of roads using the different classes of draw gear is as follows: A, ten roads, B, six roads; B^1, four roads; C, one road; D, two roads; E, three roads; F, five roads; G, two roads; H, one road. One private car line uses four forms—A, B, E and G; one road uses D as a standard, but also has in use forms B and C; one road uses B as a standard, and also has in use E; one road uses F as standard and also has in use H; one road uses D as standard and also has in use B and C.

For type A the following figures are given for cost of maintenance: Twenty-five to 30 cents per year; $1.60 per car per year; $1 per car per year. A private car line which has types A, G, B and B^1 in service gives the following ratio of cost of maintenance: A, 1; B, 0.16; G, 0.45; B^1, 0.12. A road using type B reports no repairs except those due to wrecks. A road using type E gives 30 cents per car per year. A road using type C reports very rare failures during a service of eight years. A road using type E reports cost of maintenance scarcely anything. A road using type F reports $1.20 per car per year.

The weak points reported are: One road reports trouble with type E on account of the use of not properly seasoned timber, which shrinks and allows the keys to become loose, thus putting the draft bolts in shear. This fault should not properly be laid to this type of draft gear. One road using type G reports trouble due to the bending of the draft key and stretching of the draft rods on account of the increased tractive force of the locomotives. A private car line finds the same fault with this type. Two roads using type A report trouble on account of the followers chafing against the draw timbers and cutting into the wood. One road reports trouble with type A on account of loosening draft timber bolts by gradual working lengthwise of draft timbers, not wholly prevented by draft timber keys. One road using type A finds that the trouble with it is that as it gets old the wooden draft timbers splinter and give way, and another that there is not good enough connection between draft lugs and draft timbers and subsills. Another road using type D reports one of the weak points is that as it has no good bearing on the draft timbers, and the bolts have to take a good deal of the thrust, the bolt holes are thus elongated, allowing end motion of the draft rigging. The majority of answers are to the effect that no weak points have been found with the particular style of draft rigging used.

Seven roads report having used metal draft arms principally of malleable iron. Ten roads have used metal cheek pieces, with front and back stops cast together and bolted to wooden draft timbers. Twelve roads have not used such arms. One road reports 2,000 cars equipped with metal draft arms, and states good results have been found. On the other hand, one road reports unsatisfactory results from the use of these arms on cars of iron construction. One superintendent of motive power reports the use of these arms on about 1,500 cars. The general testimony of those who have tried the metal draft arm or the cheek piece bolted to the wooden draft timber seems to be in favor of it.

A private car line reports the malleable-iron draft arms, type B^1, to have been in use about five years. They state the cost

of application to be about $1.50 to $2 more per car, and the cost of maintenance $4.40 per car per annum less. Another road gives the cost of the draft arms, type B^1, as $2.18 per car. This is the road that has about 2,000 cars equipped with these. They state they have had them in service about three years, and have had to renew none to date on account of ordinary service. The private car line above referred to as having types A, B, E and G in service gives the following ratio as the cost of application: A, 1; B, 1.19; B^1, 1.31; G, 1.19. Another road reports the cost of equipping a car with malleable draft arms at $12.50 more than with the Master Car Builders' recommended practice.

Thirteen roads report that they have used pressed steel or malleable-iron stops, and fourteen that they use only the cast-iron stop. One road uses a heavy angle-iron stop. The advantages of such stops over cast-iron stops appear to be greater in strength with less weight of metal. A few roads report unsatisfactory results with the pressed steel stop, but others say the results are satisfactory where the front and back stops are connected by a bar which serves to distribute the pushing and pulling strains among all the bolts holding the front and back stops.

Sixteen roads have used tandem or twin springs instead of the ordinary 6¼ by 8-in. double-coil spring. Eleven roads use only the double-coil spring. One road uses a triple-coil spring. All the roads using a tandem or twin spring find it of advantage in relieving shocks and saving the draft gear. In most cases where the tandem or twin springs are used they are each the same as the Master Car Builders' 6¼ by 8-in. double-coil spring. Three roads consider the 6¼ by 8-in. double-coil spring of sufficient capacity to withstand the pulling and buffing strains of heavy freight locomotives. Twenty-two roads do not consider this spring of sufficient capacity. Of the three roads favoring this spring, however, one uses with its standard draft gear two tandem springs. Another of the three finds that they have more trouble with breakages of the couplers that they are using than with the springs, and consider the springs sufficiently strong for the couplers as now made and for the method of attachment to the draw timbers. This road is using type A draft gear with the ordinary cast-iron stops.

Twenty-six roads consider the use of draw timber keys advisable. Two roads do not favor them.

Fourteen roads report that they have had no experience with the continuous type of draw gear. Eleven roads report their experience unfavorable. Four roads report good results from this type of draw gear.

Twenty-six roads report no experience with rods run from coupler back to second needle beam. Three roads report favorably on such construction. One objection brought against this is the difficulty of keep the rods tightened up as they should be in order to be effective.

The following are the conclusions arrived at by the committee:

1. The ordinary type of draw gear (type A), known as the Master Car Builders' Recommended Practice, is defined in strength both in method of attachment to draw timbers and in capacity of spring. The strains imposed upon this both in pulling and buffing by heavy freight locomotives cause frequent failures and make it an expensive draft gear to maintain.

Appendix A.

2. A form of draft gear of type B^1, with metallic draft beams and twin springs, with draft rods running to needle beams, is the most desirable. Malleable iron is the best material for the draft beams. Buffing timbers should be protected with suitable malleable-iron draft caps. The use of the twin springs is desirable, as it maintains the present standard yoke for coupler.

The committee is not at present prepared to submit any design, but is of the opinion that a proper design should follow the lines as above stated.

In conclusion, the committee would suggest that it might be desirable to make some tests to determine how much of the stock, especially of buffing strain, is absorbed by the two-coil spring and also by the tandem spring, and what is the efficiency of the various methods of attachment to the draw timbers.

JAMES MACBETH,
W. E. SHARP.

Appendix B.

2. A form of draft gear which is a modification of type B appears to be the most desirable form. Instead of using metal cheek pieces bolted to wooden draft timbers, malleable draft arms should be used bolted to the sills of the car, thus doing away with the wooden draft timbers entirely. Draft rods should be run back to the needle beams. Tandem springs should be used and arranged so as to bring them both in action in pulling and buffing. The tandem spring appears to be preferable to the twin springs side by side, as the draft arms can be brought closer together, which makes a better construction, and does not require the use of such long follower plates as the twin springs. The springs used should be the same as the Master Car Builders' standard, 6¼ by 8 ins.

The committee is not at present prepared to submit any design, but is of the opinion that a proper design should follow the line as above stated.

In conclusion, the committee would suggest that it might be desirable to make some tests to determine how much of the shock, especially of buffing strains, is absorbed by the two-coil spring, and also by the tandem spring, and what is the efficiency of the various methods of attachment to the draw timbers.

JOHN R. SLACK.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.

Thirty-third Annual Convention.

Abstracts of Reports.

(Concluded.)

THE EXTENT TO WHICH THE RECOMMENDATIONS OF THE ASSOCIATION HAVE BEEN PUT INTO PRACTICE.

Committee—F. A. Delano, A. Sinclair, H. Middleton.

[This committee prepared an elaborate preliminary paper stating, briefly, all the important recommendations adopted since 1870, arranged in convenient form, and sent copies to members with requests for statements of practice, the object being to ascertain how generally they were used. Only 23 replies were received, the number of locomotives represented by them being but 6,347. These are too few to indicate how generally the recommendations are followed. The recommendations themselves are reproduced here because of their value, and the replies are omitted.—Editor.]

On the subject of Standard Nuts, Standard Screw Threads, Bolts, Bolt Heads and Standards for Bar Iron:

In 1870 the Association recommended the formal adoption of the U. S. Standard nuts. In 1884 adopted Pratt and Whitney limit gauges for round iron to be used for Sellers' standard thread taps. In 1891 reaffirmed formally the standards of 1870 and of 1884. In 1892 adopted the standard U. S. Standard sizes of nuts and bolt heads and urged on the members of the Association a rigid adherence to the same. In 1899 Briggs' standard wrought iron pipe threads were adopted for wrought iron pipe and couplings as standard.

On the general subject of Boiler Construction, the Association has made a good many recommendations, namely:

In 1871 it recommended steam as better than hand riveting. In 1872 recommended all holes in longitudinal seams be drilled and made to match by reaming rather than by the use of a drift pin; also that hollow staybolts be used. In 1881 recommended machine riveting, especially steam riveting. In 1885 recommended making a clean metallic joint between surfaces to be calked with waste wet with a weak solution of sal ammoniac and hot water. In 1885 that in hydraulic tests for locomotives, hot water 25 lbs. above working pressure be used. In 1889 recommended the double riveting of the foundation or mud rings on boilers. In 1894 drew up specifications for boiler and firebox steel. In 1895 approved a report showing best methods of making a riveted joint and best designs therefor. In 1899 approved a report on best method of applying staybolts to boiler.

As bearing further on this subject in 1880, the Association passed on the subject of the use of Sling Stays and decided:

In 1880 that in crown bar boilers it was essential to use sling stays from the crown bars to the outside shell of the boiler. In 1894 it was recommended that in view of the greater breakage of flue sheets in radial stay boilers, due to the rigid strain of the crown sheets and placing of flues too close to the flange of the sheet, that flexible sling stays should be used to support the crown sheet at the front end. In 1896 it was resolved as the sense of the meeting that a radial stay boiler was as safe as a crown bar boiler and more easily and economically kept clean and in repair.

Bearing on the general subject of boiler construction, some recommendations in regard to Boiler Tubes or Flues have been made:

In 1886 a committee reported on the best plan of removing, cleaning and resetting boiler tubes, and it was voted as the sense of the meeting that it was unnecessary to bead the front end of flues. In 1889 a committee reported that it was almost the unanimous sentiment of the Association that the water space around the firebox should be from four to five inches; that the water bridge between flues should be ¾ in., with 2-in. flues, and that the flues should be set vertical, so as to allow better circulation. In 1895 specifications and tests were offered and adopted for boiler tubes. (See also page 296, 1899.) In 1895 (again) the question was discussed as to a uniform method of computing boiler tube heating surface. Three locomotive works and the Pennsylvania Railroad reported that they figured the heating surface by figuring the outside diameter of tubes, whereas one locomotive works figures the heating surface by figuring the inside diameter of tubes.

In 1896 a slight change was made in the standard size to suit standard gauge. In relation to these recommendations your committee desires to ask the following questions:

Referring to the subject of Standard Tank and Car Axles:

In 1879 the Association adopted the 3¾-in. by 7-in. journal for cars and tender axles of 40,000 lbs. capacity. In 1881 this was reaffirmed. In 1890 adopted the M. C. B. 60,000-lb. axle with 4¼-in. by 8-in. journal for heavy tenders. In 1891 these recommendations were reaffirmed as recommended practice.

Referring to the subject of Side Rods:

In 1882 the Association favored the "I" beam section of side rod. In 1883 approved formulae offered by Mr. F. W. Dean for design of such sections. In 1893 favored the manufacture of fluted or "I" beam side rods by machine work rather than by forging them out.

On the subject of Wire Gauges for Wire, Tubes and Sheet Metal:

In 1882 the Association adopted the Browne & Sharpe micrometer gauge, which was reaffirmed in 1891. In 1895 adopted an elliptical notched decimal gauge. (See also page 291, 1899.)

Under the general heading of the Gauge of Wheels on Axles for Standard Gauge Track:

In 1884 the Association adopted 4 ft. 5⅜ ins. as the standard width between backs of wheels for tender trucks and locomotive wheels with the limits of 4 ft. 5¼ ins. and 4 ft. 5½ ins. These conform with the M. C. B. standard.

Under the general heading of Standard Diameters or Driving Wheels and the question of Tires for Driving Wheels, the Association has taken the following action:

In 1886 certain standard diameters of wheels and standard sections of tire were adopted, varying from 38-in. to 66-in. diameter, inclusive. In 1887 a further report on this matter with the exact inside diameters of tires was adopted and the M. C. B. standard tire section also adopted. In 1893 standard outlines for flanged and plain tires were adopted, and standard sizes of wheel centers from 70-in. to 90-in. were also adopted. (See also pages 293 and 294, 1899.)

The Association has also discussed the question of Wear of Tires:

In 1887 decided that the manipulation of the sand and handling of the brakes by engineers had a great deal to do with the wear of tires. In 1895 an elaborate report on the wear of driving-wheel tires was submitted showing six different causes. In 1896 the question of Counterbalance was considered and its relation to driving-wheel tires pointed out. In 1896 (again) a report was submitted pointing out the best design for reciprocating parts in order to reduce the weight of counterbalance as much as possible.

In 1894 a report on tire treatment made the following recommendations:

Page 206. Retaining rings are necessary on wheel centers above 62 in. diameter. Page 207. Do not run tires with retaining rings any thinner than without them. Page 207. Use same shrinkage with retaining rings as without. Page 205. Drawing of Mansell ring fastening. Page 209. Minimum thickness of tires considered safe: Passenger, 1½ in., last turning; freight and switching, 1¼ in., last turning. Weight on drivers not to be considered. Page 211. Greatest permissible depth of wear of tires: ¼ in. on road engines, ⅜ in. for switch engines, but business conditions must govern. Page 216. Depth of flange permissible: Road engine, 1½ in.; switch, 1⅝ in. Drawings of instruments for measuring wear of tire and flange.

Under the general heading of Relative Proportions of Cylinder to Boilers and Grate Area, the Association has made several recommendations:

In 1887 a formula for the proper proportions of locomotive cylinders was offered. (See page 43.) In 1888 recommendations giving limits for these proportions were offered and approved. In 1897 a report was made giving valuable data as to the proper ratios of heating surface, grate area and cylinder volume for passenger and freight service, burning anthracite or bituminous coal.

On the general subject of a More Economical Combustion, the Association has taken the following action:

In 1881 comparatively high exhaust nozzles were recommended as the best practice. In 1888 the conclusion of a committee reporting on the subject of extension fronts, brick arches, etc., concluded that brick arches were an excellent thing, but should not come closer than 1 in. from the side sheet or 2 in. from the flue sheet; that 90 lbs. of coal per square foot of grate area per hour was about the maximum economical rate of combustion. In 1890 another committee on brick arches stated that the evidence was overwhelming in favor of the brick arch and extension front end. Angle irons and studs for brick arches were preferred to circulating pipes. In 1896 and 1897 a committee offered a very complete report on the proper height of exhaust nozzle and form of stack, recommending a tapered choke stack. In 1899 the Association decided by vote that it was not desirable to use bars in the exhaust nozzle.

Report of Testing Laboratories for Railways.

In 1891 a very complete report was submitted on the subject of testing laboratories for railways, showing their proper organization and province.

On the general subject of Testing Materials:

In 1892 the Association accepted a report making six conclusions, the most important of which was that steel should not be worked at a temperature between normal and a perceptible red heat known as "blue heat." In 1896 the Association again decided that it was of great importance in flanging steel that it should not be worked below a cherry red heat.

Under the general heading of Treatment of Employes, the Association has taken the following action:

In 1886 a resolution was passed that the Association deprecates giving testimonials or recommendatory letters for publication, and enjoins all to restrict matters of this nature to letters of inquiry. In 1891 a report was submitted giving advice to employers as to the best method of examining engineers and firemen, including suggestions on the education of firemen. In 1898 a report was submitted on the subject of apprentice boys and a code of rules adopted by the Association to govern their promotion.

Under the general topic of Compound Locomotives:

In 1893, the Association decided that the compound is suitable for freight service, but that its availability in passenger service was undetermined. In 1899, the Association decided that a by-pass valve to relieve the vacuum in the low-pressure cylinder when drifting was very important.

Under the general subject of Standards for Boiler Attachments, the Association

In 1893 listened to a report making eight recommendations looking to increased safety, and adopted a resolution that the water glass, although a convenience and an additional precaution against low water, was not absolutely necessary to the safe running of locomotives.

Under the heading of Tonnage Rating for Locomotives and Ton-Mile Basis for Statistics the Association

In 1898 considered favorably a report on tonnage rating, and in 1899 adopted a resolution that it was the sense of the meeting that the ton-mile basis for motive power statistics is the more practical and encourage economical methods of operating, etc.

Under the general heading of Chilled Cast-Iron vs. Steel-Tired Wheels for Cars and Locomotives:

In 1888 the Association approved specifications submitted by a committee for the manufacture of chilled wheels, giving a test, form of contract and service guarantee. In 1899, in a report on the relative merits of cast wheels and steel-tired wheels for locomotive and passenger cars, a recommendation (see page 127) was made as to the best method of keeping a record of the mileage of wheels.

On the general subject of the Best Metal for Locomotive Cylinders and Cylinder Bushings the Association has taken the following action:

In 1896 accepted a report on cylinder bushings, making five distinct recommendations. In 1897 accepted a report of a committee making four recommendations in regard to best metal to be used for cylinders, valves and valve seats.

Under the general heading of Locomotive Statistics:

In 1872 the Association adopted a report fixing an arbitrary mileage to be computed for switch engines at six miles per hour of actual service, for local freight engines 6 per cent. for switching, and also that new engines to replace vacant numbers should be charged to repairs, except any excess in cost over the old ones.

JOURNAL BEARINGS, CYLINDER METALS AND LUBRICATION.

Committee—W. C. Dallas, J. B. Barnes, G. F. Wilson.

Question.—Please give the committee what you consider the best cylinder mixture for your heaviest high-pressure engines.

The replies to the question can be arranged in three groups. The first group containing the largest number of replies is from roads which do not operate their own foundries, and they give the uniform specifications, a close-grained iron as hard as can conveniently be machined and prevent castings being subject to shrinkage cracks.

In the second group we have those who operate their own foundries or who purchase cylinders or guarantee to meet specific composition, such specifications calling for various grades of new iron and scrap.

In the third group we have those who have advanced a step farther and added to their specifications the use of a varying percentage of steel scrap with their iron constituents. Roads using specific mixtures as detailed can only be cited as an illustration of the best practice in different parts of the country where the different special irons are in convenient freighting distance, and a universal mixture would be an absurdity. The nearest approach to universality would be a mixture of irons that would give a certain chemical analysis which practice had determined would give the best results. The data at hand, however, is too limited for the committee to go any further.

In this connection it seems to be a general complaint that some of our locomotive builders make their cylinders entirely too soft, presumably for the purpose of facilitating and cheapening the cost of machining, and also assisting in preventing a loss of cylinder castings due to shrinkage causing cracking.

Question.—Do you or do you not get any advantage in casting cylinder saddles separate from the cylinders?

The deduction of the committee from the replies to this question would be that cylinders and saddles in one piece can be so designed, molded and handled in the foundry as to give perfect satisfaction and still be so secured to the frames as to be immovable, resulting in economy, not only as to first cost, but in cost of maintenance, although one road has been for the last two years using the three-piece cylinders and saddles, and from observations made at different times it seems they are having great success not only in keeping the cylinders secured, but they have been able to reduce to a minimum the time in which to apply a new cylinder. The method pursued by this road allows a different metal to be used in the cylinders than that in the saddle; plainly speaking, a hard metal can be used in the cylinders and a softer metal in the saddles. This arrangement seems to have advantages over the two-piece cylinder and saddle. [The method referred to here is that of the classes H5 and H6 locomotives of the Pennsylvania illustrated in our issue of June, 1899, and of the class E1 shown in our issue of June, 1900.—Editor.]

Question.—Please give the committee the best alloy for various bearing metals on your heavy and fast passenger engines.

The question of proper bearing metal for heavy fast passenger service is an important one, but it would seem from the various replies received, each one having good success with their own mixtures, that it is a question for each road to decide, after taking into due consideration designs of engine,

weight on square inch of bearing surface, road bed and ballast conditions, methods of oiling and quality of lubricant used.

Undoubtedly one of the best metals for locomotive bearings and connecting-rod boxes is what is known as "phosphor-bronze," "S" grade:

Copper	79.70 parts.
Tin	10.00 parts.
Lead	9.50 parts.
Phosphorus	.80 parts
	100.00 parts.

The reason the above mixture is far superior to any other is owing to the fact that copper and tin phosphorized gives it a greater affinity for lead, by which it will be understood that by the method of phosphorizing employed copper is made more fluid and in a manner cleaned, which causes it to amalgamate with the lead, and lead being a natural lubricant it has its advantages in the mixture by being held in solution, and in case of a bearing becoming neglected regarding oil for a short period, the lead in a manner fulfils the want of oil.

In conclusion, the committee would state that no matter what the mixture may be, foundry practice assumes almost as important a part as the mixture, to prevent hot bearings, and should be given careful consideration.

Question.—Do you experience any difficulty in lubricating cylinders and valves and machinery on your high-pressure heavy and fast passenger engines? Please give the committee the benefit of your experience on this subject.

To this question, the majority of the roads replying say that with improved lubricators, proper piping and the use of a good lubricant and high grade of oil, they are experiencing very little difficulty.

Commenting on the replies to this question, it is the opinion of the members of this committee that with the modern lubricator, properly applied and operated, very little difficulty should be encountered in securing proper lubrication to valves and pistons, providing a proper lubricant and sufficient of it is used.

Question.—What do you consider the best method of locating oil holes, oil grooves and oil pockets in driving boxes?

Answering this question, the majority of the roads favor oiling journal driving bearings by carrying oil to crown cavity, either centrally from one oil pocket, on top of box, or from two cavities on top of box by means of holes drilled at an angle to reach crown cavity.

The Chicago, Burlington & Quincy Railroad replies that it has tried and is still trying oil holes and oil grooves on the side, and has tried to do away with the center oil hole in the top, but thus far with only moderate success. The trouble seems to be that the waste from the driving box is grated up and soon plugs up the grooves and the oil holes on the rear side, and if the box runs at all warm the metal tends to "wipe" over the groove on the front side. On the whole, it seems that the side oiling is of very doubtful advantage.

The New York Central & Hudson River Railroad favors lubricating at the side just above the center of the axle. Its experience in oiling driving boxes that way has been somewhat limited, although on a number of engines being turned out with holes drilled toward the center of the boxes the result has been very satisfactory.

The Southern Railway of Peru says that it locates oil holes on the sides of journal boxes and has done away with oil grooves and pockets, depending upon the cellars for lubricating the journals.

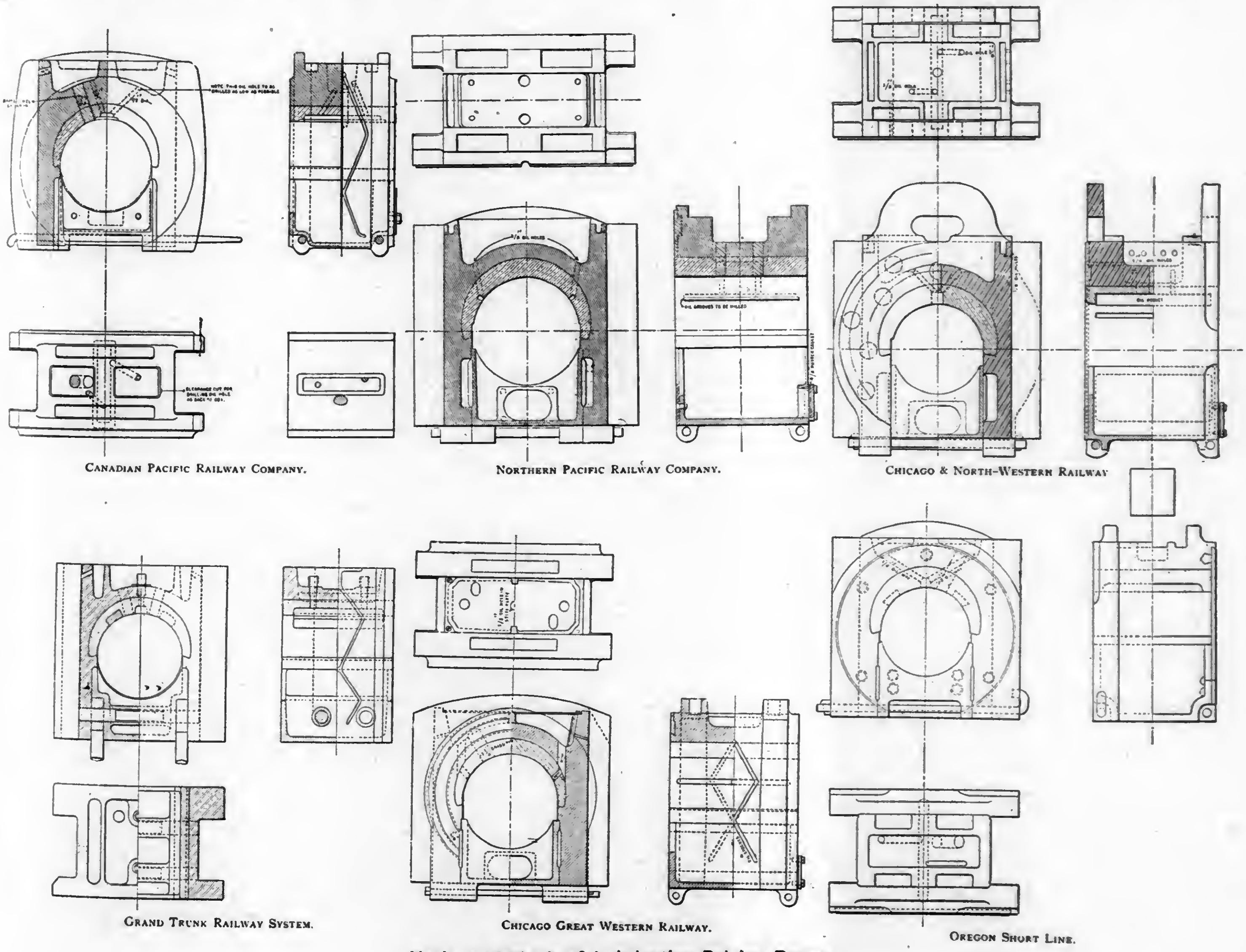
The Boston & Maine Railroad advises that driving boxes are best oiled by two oil grooves running lengthwise of bearing located on each side well away from the crown, oil holes leading to these grooves from large pockets in top of box.

The following roads furnished blue prints of their methods of lubricating driving boxes: Chicago & North Western, Grand Trunk, Canadian Pacific, Oregon Short Line, Chicago Great Western, Mexican Central and Northern Pacific.

PRESENT STATUS OF COMPOUND LOCOMOTIVES.

Committee—J. F. Deems, A. E. Mitchell, John Player, J. E. Sague, J. H. Setchel.

The great source of waste in the use of steam in a single cylinder is the alternate heating action of the entering steam and the cooling effect of expansion and condensation on its walls and the consequent wasteful condensation and re-evaporation of steam. Any expedient which will reduce this waste by preventing the transfer of heat from the steam to the



Various Methods of Lubricating Driving Boxes.

exhaust side of the cylinder without transformation in proper proportion into work, will reduce this loss and increase the efficiency of the machine.

This is effected in compound locomotives by a limited expansion, submitting as far as may be necessary to cylinder condensation and re-evaporation, but then transferring the working steam, both the condensation and the re-evaporation, to a second cylinder, in which the latter portion may either do some work or balance its waste more or less fully.

The question of adoption of the compound engine for the usual work of the locomotive where speed, pressure or load, either or all, is expected to be variable, is complicated by the fact that it is impracticable to find cylinder proportions which will be permanently suitable. Notwithstanding this difficult feature in design, the demand for larger engines and the thin partition which divides a net profit from a loss in railway operation render it well-nigh imperative that a solution be found for this perplexing problem. The heavier a locomotive, the smaller is the relative boiler capacity that can be supplied.

The limit in steam production once reached, the required gain in power can be attained only by a more economical use of the steam generated, and if the compound has the advantage claimed by its advocates, it seems that it will of necessity be adopted. The advantages accruing from compounding may be summarized as follows:

1. Reduction of expansion in one cylinder and consequent reduction of internal waste. 2. Ability to adopt large ratios of expansion with light loads without wire drawing. 3. Reduced leakage in engine. 4. Reduction of depreciation of boiler. 5. Greater boiler efficiency. 6. Lighter blast, smoother draft, less waste, annoyance and danger from sparks ejected from locomotives. 7. Elevated limit of speed and power. 8. Reduced loss by tender and fuel haulage. 9. Greater uniformity of crank movements. 10. Larger efficiency of machine.

To offset these gains, there are losses which may be enumerated as follows:

1. Increased first cost. 2. Increased cost for repairs and maintenance of machinery due to multiplicity of parts and greater weight of reciprocating parts.

After a careful consideration of the question as it has been presented before the Association in previous years, it would seem that there has been a steady growth of sentiment in favor of the compound, not only for slow freight, but also for express service; that many of the failures in its early days were not those of a wrong principle, but of faulty design, which source of trouble has to a large extent been remedied.

In recent years the number of compound locomotives which have been placed in service by the different roads has made the possibility of obtaining comparative data as to their performance, relative to simple engines, rather less difficult than formerly. Many roads using both types of engines have tabulated the performance of their engines for long periods of time and in several cases exhaustive tests have been made to determine their relative merits. In view of this fact, the present committee did not feel called upon to treat the subject from this standpoint, but rather to determine as far as possible the general opinion concerning the compound among those having them under their care, and to secure figures showing what net gain, under actual service conditions, might be due to compounding.

In the proceedings of the Western Railway Club for March, 1899, appears a paper by Mr. E. M. Herr, giving the record of compound locomotives on the Northern Pacific Railway. The paper is of particular value, as the records cover a considerable period and are compared with the records of simple engines of the same class for a similar period. Mr. Herr states "the object of the paper is to endeavor to bring out some discussion as to the advisability or inadvisability of the use of compounds for heavy freight service. From my experience on the Northern Pacific road, my judgment is that it is advisable to use the compound locomotive in heavy freight service. I say advisable because of the economy in fuel, and as far as our experience went, no appreciable, or at least no important, increase in the cost of repairs. It certainly seems advisable to use a machine that shows a saving of from fifteen to twenty per cent. of fuel in regular service and no very great or even appreciable increase in cost of maintenance."

In the discussion which followed the reading of this paper, the subject of the advisability of using compounds for passenger service came up, and the prevailing opinion was that for fast heavy service they were economical engines to use. Attention was called to the fact that as the compound was a comparatively new machine, careful attention should be given it, the cause of failure in any part should be determined and the evil remedied; that the most of the failures are not those of the compound feature, but of parts common to both types of engines, but which in the compound might require a design differing from that common to good practice in the simple engine.

In view of the data presented and the expressed opinions in the answers to the circular of inquiry, the committee believes the following conclusions are justified:

1. Compound locomotives have not come into general use in America, but are gradually emerging from the experimental stage. 2. Compounds have been in use in freight service longer than passenger service and there are more in such service; but in recent years there seems to be a disposition to use them also for fast, heavy passenger service. The compound is not as well adapted to switching service as the simple engine. 3. The ton-mile system forms the basis of comparison between compound and simple locomotives. The average saving of the compound in coal consumption is 16.5 per cent. 4. The actual saving of the compound depends upon the price of coal. The greatest economy will be attained where the compound is worked continuously well up to its limit. The opportunity for saving is greater in freight service than in passenger. 5. The compound is not so flexible an engine as the simple. 6. There should be no difference in the size of drivers between the compound and simple engine in the same service. 7. The compound may be successfully pooled, if such practice is followed, with simple engines. 8. The rating for compounds should be no higher than simple engines of the same class, weight and steam pressure. 9. If it be desired to work the engine simple over maximum grades, the rating may be slightly higher for the compound than for the simple engine. 10. The correct ratio of cylinders is difficult to determine, as other factors than the determination of such ratio as will secure the minimum cylinder condensation enter the question. In the two-cylinder type it is of paramount importance that the work in both cylinders be equalized as closely as possible for all positions of the reverse lever. This is easier accomplished if the ratio be kept down, and in freight engines it seems that a ratio of about 2 1/3 to 1 would be acceptable, while for passenger a slightly higher ratio, 2.37 to 1, might be used. For the four-cylinder compound the most important question is that of equalizing the pressure on the high and low pressure pistons, and a ratio of 3 to 1 gives good results. 11. Manual control of compounding feature is preferable to the automatic. 12. There is no necessity for having any trouble due to the use of a large cylinder if proper care be used in the design of the piston. 12½. There is less danger of setting fires from the stack of the compound than of simple engines. 13. It is necessary to relieve the cylinders while drifting, large relief valves being used on four-cylinder compounds and the by-pass on two-cylinder compounds. 14. The piston valve is preferable to the slide valve, as more perfect balance is secured, and consequently less wear of valve and seat and less strain on valve motion. 15. When comparisons have been made between compound and simple engines, the pressures were usually the same. 16. In starting it is necessary to work the engine simple; that it is bad practice to so rate the engine that it will be necessary to work it simple over heavy grades. 17. Engineers are apt to abuse the privilege of working the engine simple. With the same supplies at hand for the repairs on compound engines, there is no necessity for the compound remaining out of service for repairs any longer than the simple engines. 19. The cost of boiler repairs is less on the compound and may average 19.6 per cent. less than for the simple engine. 20. The cost of maintaining the machinery on the compound is a little more than on the simple. 21. The cost of lubrication on the compound will be about 15 per cent. more than on the simple engine. 22. The compound will be an economical machine whatever the price of fuel. 23. More compounds are in use where the fuel is expensive than where it is cheap. 23½. There is no necessity for any difference in the size of the exhaust nozzle of the compound and that of the simple. 24. Many and careful comparisons have been made of the relative performance of the compound and simple engine, and the position of the compound in railroad economy may now be determined. 25. It is possible to build a compound that will give satisfaction equal in tractive power to any of the simple engines. 26. The low-pressure piston will give better results if made of cast steel with a bronze bearing ring cast in its periphery. 27. The most notable improvements have been in the intercepting valve, in steam distribution and better design of the machinery. 28. Attention is called to the necessity of further improvement in design of machinery, intercepting valve and steam distribution. 29. With the modern machines the compound holds its place as against the simple and it is not advisable to change any in use into simple engines.

PISTON VALVES.

Committee: S. P. Bush, Wm. McIntosh, H. Schlacks.

Two weeks after the appointment of the committee last year, a circular was prepared asking certain questions covering the use of piston valves in locomotives. This circular was sent to all the members of the Master Mechanics' Association, and while a comparatively small number of the members are using piston valves on their locomotives, yet it is found that a majority of those that have used the piston valve make replies which in nearly all cases are exceedingly favorable to the piston valve.

It is not the intention of the committee to go into all the numerous details of piston-valve constructions that have been tried, inasmuch as most of the variations are the result of individual opinions as to construction and do not affect the general result. The committee feels, however, that it can cover the important features in this report and speak with reasonable certainty. As stated previously, nearly all of those reporting as having had experience with the piston valve speak favorably of it, and this, in the judgment of your committee, is satisfactory evidence that it has merit.

The advantages of the piston valve are generally stated as follows:

For steam pressures exceeding 185 lbs. the piston valve offers considerably less resistance than the slide valve, thus reducing the work the entire valve gear must perform, and reduces the internal resistance of the locomotive, which is thought to be considerable in modern high-pressure engines.

For steam pressures higher than 185 lbs. the question of valve lubrication is very much simplified, and the difficulties of cut valves and seats are very much diminished.

The cost of maintaining the piston valve seems to be no greater than that of maintaining the slide valve. This statement is not based on a large number of figures, but rather on the judgment of those using the piston valve.

The area of admission and exit openings can be very materially increased with the piston valves, which, with higher power locomotives, seems to be a very important advantage; and it is well known that, in order to obtain the highest efficiency from a locomotive it is not only necessary to get steam into the cylinder promptly, but to get it out again.

These are, in short, the advantages of the piston valve that seem to have been demonstrated. The committee believes that, in adapting the piston valve to the simple engine, the internal admission type has possibly a slight advantage in that the loss of heat by steam is somewhat less than in the case of the external admission type.

Some railroads and locomotive builders, when designing valve gear for piston valves having internal admission, assumed that the valve gear as designed for external admission would answer for those with internal admission. Practice develops that this is a mistake, and that in order to obtain the proper steam distribution, the valve gear must be specially designed for the internal admission.

In designing the piston valve attention is called to the necessity of obtaining the benefit of all the area of admission and exhaust which the principle of the piston valve affords. The committee thinks that this has not always been taken advantage of to the full extent.

One point in piston-valve construction that has been found to have a material effect on steam distribution has been somewhat overlooked, namely, the difference in area between the forward and rear; the area of the rear end being reduced by the area of the piston rod; the two ends are therefore out of balance, and as a result the motion of the valve in one direction is deranged as compared with the motion in the other direction, inasmuch as the lost motion in the valve gear is taken up in an opposite direction from that which is ordinarily the case. This is based upon experiment on the part of the committee, and from the statement of an individual to the effect that a locomotive equipped with piston valves ran for quite a distance with one of the valve stems broken, the valve making its regular movement by being pushed ahead by the end of the broken valve stem in one direction, and pushed back again in the opposite direction by the excess pressure on the forward end of the valve.

The committee finds a great variety of packing used for piston valves. It can be said, however, with perfect certainty, that plain snap packing rings will give entirely satisfactory service.

TON-MILE BASIS FOR MOTIVE-POWER STATISTICS.

Committee—H. J. Small, C. H. Quereau. Mr. W. H. Marshall dissenting.

In the report of this committee presented at the 1899 meeting we argued at length that all the items involved in the Cost of Engine Service statement should be based on the ton-mileage produced. It is not our intention to present this matter at length in our present report, but wish to emphasize the conclusions reached in that report by an illustration taken from a performance sheet for January, 1900, in which is shown the records made on the mile and ton-mile bases.

	Moguls, Simple. 19 by 24.	Consolidat'ns, Compound. 21 by 31 by 24.	Per cent. in favor of Simple Engines.
Cost per *Mile*.	Cents.	Cents.	
Oil and waste	.24	.30	25
Fuel	14.81	15 84	7
Repairs and supplies	2.51	5.08	103
Wages	6 93	7.63	10
Total	24.49	28.83	18
Cost per 10,000 *Ton-Miles*.			Per cent. in favor of *Compound* (except**).
Oil and waste	$ .04	$ .03	33
Fuel	2.44	1.77	8
Repairs and supplies	.41	.58	40**
Wages	1.14	.85	134
Total	$4 03	$3.23	25

We believe the showing in the above tables a sound argument in favor of the use of the ton-mile basis, and for all the items making up the cost of engine service. We believe it advantageous to also have a statement showing the cost of engine lubrication and illuminating oils on the engine-mile basis.

Comparison of Statistics.

In our previous report we also argued that greater economies will be secured by comparing the statistics for a given system or division with those made by the same line in previous years, rather than with those of other roads, because when the comparison is made with other roads the conditions, which very largely control results, are, almost as a matter of necessity, so different that a just comparison can not be made, while this is not true when the comparison is with previous records made on the same line. In this report it is our intention to only emphasize this point and refer to our previous report for the extended argument.

What Service Should be Included?

The chief reasons for adopting the ton-mile basis for railroad statistics, in place of the mile basis, are that the former is a more accurate measure of the work done, and encourages economy in operating. We can see no good reason why these qualities are not as desirable for passenger service as for freight, though it will be admitted that greater economies will result in freight service. It is urged by some that the speed and weight of trains in passenger service are not within the control of division officials, implying that there is little use in trying to improve the records for this service, therefore there is no use in using the ton-mile basis for these statistics. This reasoning applies with equal force to a large proportion of freight service, such as stock, fruit express and fast merchandise, but is not considered to have sufficient weight to prevent the use of the ton-mile basis. We know that some men are more economical than others in passenger service, as well as in freight, and believe the use of the ton-mile basis is better than the engine-mile basis with which to determine their relative merits, and so encourage better records. It also seems to us desirable that both passenger and freight service statistics be on the same basis. This is apparently the view of nine out of the fourteen roads reporting, or nearly 65 per cent. To the actual weight of cars in passenger service we would suggest the addition of five tons for mail, baggage and express cars in main line service, three tons for such cars in branch-line service, and of two tons for such cars as carry passengers, whether in branch or main line service. Passenger cars hauled deadhead in freight trains should have no such credit.

Engines in work train and switching service are credited with an arbitrary number of miles per hour. We see no reason why they should not be credited with an arbitrary ton-mileage instead, which would give the same basis for the statistics of all classes of engine service which we believe is important and desirable. Nearly 22 per cent. of the roads reporting are of this opinion.

We would suggest that work engines be credited with the actual weight of their trains, to be determined on the same basis as for freight engines, and with ten miles per hour. If the weight of the train is 500 tons, and the engine is in service ten hours, the credit for the day's work would be 5,000 ton-miles.

For 18 by 24-in. switch engines carrying 145 pounds of steam pressure and having 50-in. driving wheels, we would suggest a credit of 200 tons and eight miles per hour. For a day of ten hours this would make a credit of 1,600 ton-miles. For other switch engines the tonnage should be proportional to their power as determined by the formula in the next paragraph.

The credit for pusher and double-heading engines should be made on the basis of the proportional power of the engines attached to the train. This is quite easily determined by means of a table which can be made in the drawing-room, from the tractive power formula.

We would sum the argument for the use of the ton-mile basis for all classes of engine service as follows: It is the most accurate practicable basis for measuring the work done in freight and passenger service; an arbitrary ton-mileage credit for switch engines is as accurate as an arbitrary mileage credit and has no disadvantages; for work engines a credit for the actual tonnage handled and an arbitrary mileage per hour is more accurate than a credit of an arbitrary mileage only; it is desirable to have the same basis for all classes of engine service.

What Tonnage Should be Included.

There are evidently differences of opinion as to what tonnage should be included in making statistics. Some are decidedly of the opinion that the entire weight of the train, including the engine, tender and way-car, should be used. Others contend, with equal conviction, that only the weight of the cars and their contents, excluding the way-car, should be used. It is quite possible that this difference of opinion may in some cases be due to a confusion of the terms "ton-mileage" and "tonnage rating." The ton-mileage of a locomotive for a given trip is ascertained by multiplying the weight of its train, reduced to tons, by the number of miles this tonnage is hauled. The tonnage rating of the same engine is quite a different matter, being simply the number of tons it is rated to handle, and does not necessarily have any relation to its ton-mileage. As the weight of a given engine and its way-car is always the same, there is no good reason why the tonnage rating should include these weights, as the object of the tonnage rating is simply to always secure a weight of train which shall be the greatest practicable under service conditions.

It may seem that this line of reasoning should be applied to the ton-mileage, and that, because there is nothing gained by including the tonnage of the engine and caboose in the tonnage rating, therefore it should not be included in the ton-mileage. It seems to your committee that this does not logically follow, because the object of the tonnage rating and that of the ton-mile basis for statistics are entirely distinct. The tonnage rating is used as a measure of the capacity of the locomotive, while the ton-mileage is intended to show the work actually done, regardless of whether the tonnage rating is handled or not, as a basis for the cost of engine service.

One of the favorite arguments of those who favor the exclusion of the ton-mileage of the engine and way-car is that

the management wants to know what their engines are hauling behind the tender. Admitting, for the sake of argument, that this position is correct, no better statement could be made to show that the weight of the way-car should be included in the ton-mileage.

It is argued that there are engines of modern design which will haul more tons of freight behind the tender for each ton weight of engine than others, which are not so well designed, and therefore the weight of the engine and tender should not be included in the ton-mileage, so as to make a better showing for the modern design. We question the relative importance of this information, believing that the cases where it would apply are comparatively limited, and that the desired information could be obtained more accurately either by calculation or special tests. In short, that it is more important that the motive-power statistics be based on a ton-mileage which will represent as nearly as practicable the total work returned for the money spent than to leave out of the account a considerable percentage of the work done for the sake of exceptional conditions.

It is claimed by some that the weight of engine and tender should be omitted on the same basis that the owner of a stationary engine wishes to know the power delivered by the fly-wheel rather than the total power developed in the cylinder. The cases are quite different. The power absorbed by the stationary engine is simply that necessary to overcome the internal friction, amounting possibly to eight per cent. of the total developed, and it does not run without a load. With a locomotive, in addition to the internal friction, there is the power absorbed in moving its own weight, which frequently, even with its maximum load, amounts to 35 per cent. of the total power developed. In rating and judging the efficiency of a stationary engine both its owner and builder include in the work performed that absorbed by the shafting which it drives, amounting frequently to 50 per cent. of the total power developed, and frequently that absorbed by internal friction. It would seem that those who advocate the omission of the ton-mileage of the locomotive and its tender can find scant grounds for their postition from stationary practice.

Viewing the matter from a strictly motive-power standpoint, we are of the opinion that the ton-mileage should include the entire train—the engine, the cars with their contents, and the way-car. The strongest argument in favor of this view is that the best basis for determining motive-power costs is that which includes all the work produced by the money spent. The management is specially interested in knowing the cost of hauling a ton of paying freight one mile. This would exclude from the ton-mileage that of the engine, the light weight of the cars, including the way-car, and of company material. It is exceedingly doubtful if any motive-power official will claim this is a proper basis from which to find out whether his department is being managed economically or not, simply because it evidently would not furnish an accurate measure of the work done by the money spent. As it would give no credit for work done in hauling empty cars, company material, for an engine and way-car, or for a light engine, we would justly argue that statistics on such a basis could not fairly be used to measure our efficiency as motive-power officials, and would be of little practical use in helping us to reduce costs intelligently. Empty cars and company material must be hauled; locomotives with only a caboose, and without a caboose, must run over the road; this work necessitates an expenditure of money by the motive-power department and is in no way under its control. Is it not reasonable to claim that there should be a credit for this unproductive work against which to charge the money spent in doing it?

Under the head of "Statistics" it is worth noting that, of the fourteen roads reporting, on all but one the operating department uses the ton-mile basis for their statistics. The needs of the operating and motive-power departments in this matter are quite different. The operating department wishes to know the per cent. of empty to loaded ton-mileage, the per cent. of actual to rated ton-mileage, the average tonnage of load per car, so that the per cent. of useful work may be increased. On the other hand, these matters are of minor interest to the motive-power official, and then only as they affect the efficiency of his department. The motive-power officer is interested in knowing the actual work performed, not with a view of bettering the efficiency of the operating department, but his own.

If our statement of the case is correct, it follows that there are three interests to be served by ton-mileage statistics: Those of the management, which wishes to know the cost of handling a ton of freight one mile; those of the motive-power department, which we believe is entitled to a credit for all the work performed by the money it is responsible for; and those of the operating department, which finds the ton-mile basis the best practical one for reducing the per cent. of unproductive work in handling their trains. If this is a fair statement of the case, it follows that the needs of no two of the departments are the same, and therefore a compromise will serve the best interests of neither. It will be admitted that the management is interested in the statistics of both the other departments, but we venture to assume we are warranted in believing that it is to the best interests of the management to allow each such a basis for their statistics as will favor its greatest efficiency.

There is an opinion, judging by editorial comments and personal remarks, that the expense for the three statements which we advocate will be prohibitory. We believe that a study of the facts will show that such is not the case. For the motive-power ton-mileage the addition of that for the engine and way-car will cost practically nothing, as will be readily understood when attention is called to the fact that these are constants for any given district and will not have to be figured out for each trip. For instance: A 15-ton caboose going over a 120-mile district will have a ton-mile credit of 1,800 for each trip; a 200-ton engine on the same district will have a credit of 24,000 ton-miles for each trip; and on each district there will be such a constant. The additional expense for adding these constants to the footing of the ton-mileage for the operating department, which should not include them, will be scarcely appreciable. On one road the ton-mileage of the engine is added in the office of the Superintendent of Motive Power, where the weight of each engine and its mileage are known.

It is probable that the ton-mileage statistics of the operating department should show separately that for the lading, for the loaded cars, for the empties, and east and west bound traffic in order to be of the greatest usefulness. If this is correct, it follows that the additional expense for furnishing the ton-mileage for the management, which should show only that for the contents of the cars, would be only that necessary to draw off these figures as a separate statement from among the totals needed by the operating department. It would therefore appear that the expense for ton-mileage figures for each department, best suited to its uses, would be but very little greater than for a compromise statement which would serve the best interests of neither.

The preceding argument has referred only to the expense for compiling the ton-mileage. We believe it safe to assume that the expense for figuring out the statistics based on ton-mileage will, after the first year, be no greater than it has been for furnishing the corresponding statistics on the mile basis. This has been the experience of others and seems a reasonable proposition. If the ton-mile statistics are more elaborate, it will follow that the expense will be somewhat increased. In this connection it is worth noting that for the first year the ton-mile statistics are used; it will be necessary to keep those based on the mile, if a comparison of one year with another is desired.

Conclusions and Recommendations.

The ton-mileage for the use of the motive-power department should include the weight of the entire strain.

For the use of the operating department it is probable that all that is needed is the weight between the tender and way-car.

The best interests of both departments will be best served by a joint committee representing both.

For the Motive-Power Department.

We recommend that all the items making up the cost of engine service be on the ton-mile basis;

That the statistics of all classes of engine service be on the same basis;

That in passenger service five tons for mail, baggage and express cars in main-line service, three tons for such cars in branch-line service, and two tons for all cars carrying passengers, be added to their scale weights; passenger cars handled deadhead in freight service should have nothing added to their scale weight;

That engines in work train service be credited with the actual weight of the entire train, to be determined on the same basis as for freight engines, and with ten miles per hour;

That switch engines having 18 by 24-in. cylinders, carrying 145 lbs. steam pressure and having driving wheels 50 in. outside the tire, be credited with 200 tons and eight miles per hour; for others the tonnage should be in proportion to their power, compared with that of the standard, and eight miles per hour;

That for pusher and double-heading service the credit for each engine attached to the train be its proportion of the ton-mileage, based on its power, for the distance covered by each;

That it is desirable to group the individual fuel statement and oil statement, each service by itself;

That the statistics for main line and branches be separate;

That the weight of the contents of freight cars handling way freight should be that with which it left the terminus;

That the ton-mileage of mixed trains, where both freight and passengers are handled in the same train, should be credited to that service which is entitled to the greatest per cent. of it;

That the tonnage of a locomotive should be its weight in working order plus that of the tender with half its capacity of coal and water.

RELATIVE MERITS OF CAST-IRON AND STEEL-TIRED WHEELS.

Committee—J. N. Barr, A. M. Waitt, H. S. Hayward, A. L. Humphrey, John Hickey.

The only report giving data has been received from the Union Pacific Railroad, in which they state that the average cost of mileage of 33-in. cast-iron freight car wheels is 8 cents per thousand miles; the average cost of steel-tired wheels is 45 cents per thousand miles.

Mr. G. W. Rhodes, of the Burlington & Missouri River Railroad, advises that he is of the opinion that 33-in. cast-iron wheels made to the M. C. B. standard test is a safer wheel than some of the steel-tired wheels on the market.

Under these circumstances, your committee is unable to add anything additional to the report printed in last year's proceedings.

AMERICAN ENGINEER AND RAILROAD JOURNAL.

SEPTEMBER, 1900.

CONTENTS.

IF NOT, WHY NOT?

Possible Economies in Locomotives.

By Mr. M. N. Forney.

To the Editor:

In a recent issue one of your contemporaries makes the statement that "the indications are" that under similar conditions the coal consumption of the new "Northwestern type of locomotives"—which was illustrated in the July number of your excellent paper—"is about 20 per cent. less than with the standard eight-wheel engines, having smaller boilers and grates." The "Northwesterns" are simple or single-expansion locomotives. As there is a great deal of testimony afloat showing that compound locomotives also save 20 per cent. of fuel, could it be inferred that if the "Northwestern" engines were compounded they would save 40 per cent.—if not, why not?

It can also be proved theoretically and practically that for each 12 degrees that the feed-water is heated by the exhaust steam or waste gases, before the water enters the boiler, there will be an economy of 1 per cent. of fuel. Now steam of 200 lbs. pressure has a temperature of 388 degrees. That of the exhaust steam is about 235 degrees, and the waste gases vary from somewhere about 350 to 1,200 degrees. It would, therefore, seem to be entirely practicable to raise the temperature of the feed-water up to 300 degrees before it enters the boilers. If the feed-water has an initial temperature of 60 degrees the heat added would be equivalent to an economy of 20 per cent. more. If, then, a "Northwestern" locomotive was compounded and a feed-water heater was added, why would it not be possible to save 60 per cent. of the fuel?

The technical papers have recently had accounts of super-heaters tried in Europe on locomotives, and various economies have been claimed. From what has been accomplished by this means with stationary engines a saving of 10 per cent. would not seem extravagant. The addition of a super-heater in a locomotive ought then to carry the economy up to 70 per cent. If not, why not?

The introduction of wide fireboxes have also brought with them another problem. The big grate is undoubtedly very useful when a locomotive is working hard, but is quite too large when the loads and the grades are light, and the speed slow. Now to meet this difficulty the writer has designed a grate of which the open area can be increased or diminished as required, and can thus be adapted to the work to be done. It has never been tested, but a saving of 10 per cent of fuel by its use with a wide firebox, and thus improving the combustion, seems to be quite within the reach of possibility. This would carry our economy up to 80 per cent. If not, why not?

In France what are known as the "Serve" tubes have for some time been extensively used. As probably most of your readers know, these tubes have a number of longitudinal ribs on the inside whose purpose is to absorb the heat from the products of combustion and conduct it to the water on the outside of the tubes. Having no data at hand showing how much economy is effected by the use of these tubes, it will be assumed to be 10 per cent., which brings the total up to 90 per cent.

According to the testimony of master mechanics, locomotive superintendents and locomotive runners the world over, one of the most efficient fuel savers is a good fireman, and probably any amount of testimony could be obtained to the effect that the most skillful and intelligent firemen and engineers can easily run a locomotive with 10 per cent. less fuel than will be consumed by ordinary men. This would bring the economy up to 100 per cent. If not, why not?

We have not quite reached the perfection of the crank's cooking stove, which had so many appliances attached to it for saving fuel that he finally found he could use it for a refrigerator.

Of course there is a fallacy underlying all of the above irony—no pun intended. If the "Northwestern" type of locomotive saves 20 per cent. of fuel—the original consumption being, say 100—the latter would be reduced to 80. Now, if the compound system would save 20 per cent. it would then be 20 per cent., not on the original 100, but of 80 = 16, leaving 64 as the consumption. The feed-water heater might then save 20 per cent. of that, which would leave the consumption 51.2. By successively deducting the 10 per cent. economy of the super-heaters, 10 more for the improved grate, 10 for the Serve tubes and 10 for skillful engineers and firemen, and we will have left 37.4 as the consumption, or a saving of almost two-thirds.

Now probably no master mechanic or experienced locomotive superintendent would read a statement of even this kind without being disposed to thrust his tongue into his cheek and wink one eye. He would not only be skeptical about such a statement, but would probably be quite atheistical in his unbelief. But the economies cited above are well authenticated. There is no reason to doubt the statement of your contemporary that "the indications are that under similar conditions the coal consumption of the Northwestern engine is about 20 per cent. less than with standard eight-wheel engines having similar boilers and grates." From the reports of the economy of compound locomotives, which have been put out by the builders of them, it may fairly be inferred that they will guarantee that the fuel consumption of any simple engine will be reduced 20 per cent. by compounding it. The refrain—if not, why not? may, therefore, be repeated.

With reference to feed-water heaters, the only question of doubt involved is the possibility of heating the water from a temperature of about 60 degrees to 300 by means of the exhaust steam and waste gases. To heat a pound of water of that initial temperature up to 300 degrees will require 240 units of heat. Taking the average pressure of the exhaust steam at eight pounds it will contain 1,185 units of heat, or 1,125 more than it did when it was feed-water.

The amount of air required to burn each pound of coal in a locomotive boiler may be taken at 17 lbs. As this combines in various ways with the coal the weight of the products of combustion would be 18 lbs. for each pound of coal burned. If the average temperature of the gases be taken at 600 degrees and their specific heat at one-quarter that of water, each pound

of the gas would contain 135 units of heat counted from a temperature of 60 degrees, so that for each pound of coal burned there would be 135 x 18 = 2,430 units of heat in the gases escaping out of the chimney for each pound of coal burned. If 7 lbs. of water are evaporated per pound of coal there would be 347 units of waste heat escaping from the chimney in the gases for each pound of water evaporated. This added to the 1,125 in the exhaust steam gives 1,472 units of waste heat which escapes for each pound of water evaporated. As it requires only 240 units to raise the feed-water from a temperature of 60 to 300 degrees it will be seen that there is an abundance of waste heat to do what is proposed if we can only catch it before it escapes. A saving of 25 per cent. by heating the feed-water, therefore, seems quite possible. Of course there are difficulties, the chief one being that of providing sufficient heating surface in a feed-water heater.

That a very great economy results from super-heating steam has been shown very often both by theory and practice. Authorities have given it from 7½ to 17½ per cent., 10 per cent., therefore, seems a moderate estimate.

There can be no doubt that in no way can good combustion be so thoroughly effected as by regulating the supply of air to the requirements of the fire. Without going into an elaborate analysis it may be said that it is obvious that when a small quantity of coal is burned in a given time that less air is required and a smaller grate is sufficient than is needed when the maximum amount of coal, say 200 lbs. per square foot of grate per hour, is burned. For that reason it is thought that a grate whose size can be adapted to the rate of fuel consumption would produce much more perfect combustion than the present grates do whose size is unalterable; 10 per cent. of saving does not seem extravagant.

The difference which can be effected in operating any locomotive by good men need not be discussed.

It is not clear from the statement which has been made to what cause or causes the superior economy of the new "Northwestern" engine is attributed. It is said that "the coal consumption is about 20 per cent. less than with the standard eight-wheel engines, having smaller boilers and grates," so that the economy or a part of it may be attributed to the size of the boiler and grate.

The saving which can be effected by compounding, whatever it may be, will be due to a totally different cause; that is, to a more economical use of the steam. The economy of heating feed-water is due to the saving of what would otherwise be waste heat. This is also true of superheating, but which not only saves waste heat, but it improves the quality of the steam and its effectiveness for doing work. An adjustable grate on the other hand effects combustion alone, and should cause a given quantity of coal to produce a greater quantity of heat. The Serve tubes, however, act by what might be called frugality, very much as feed-water heaters do; that is, they save heat which without them would be wasted.

A good engineer and fireman may effect a saving in many ways; they may augment the saving by any and all of the causes enumerated, and by others which have not been referred to. The point which it is desired to emphasize is that nearly all these means of economy act in different ways, and on what may be called different functions of a locomotive, so that excepting in those instances which have been mentioned the saving effected by one is quite different from that which would result from the employment of the others. If then some very considerable economies are not possible in locomotives why not? which is the question this article was intended to propound.

M. N. FORNEY.

The protection of boiler tubes by electro-galvanizing is used extensively in England and abroad, the English Admiralty now specifying that all boiler tubes shall be covered externally with a coating of zinc equal to 1¼ oz. per square foot.

80,000-POUND SIDE-DUMP CARS.

For Coal, Ore and Ballast.

Cleveland, Lorain & Wheeling Railway.

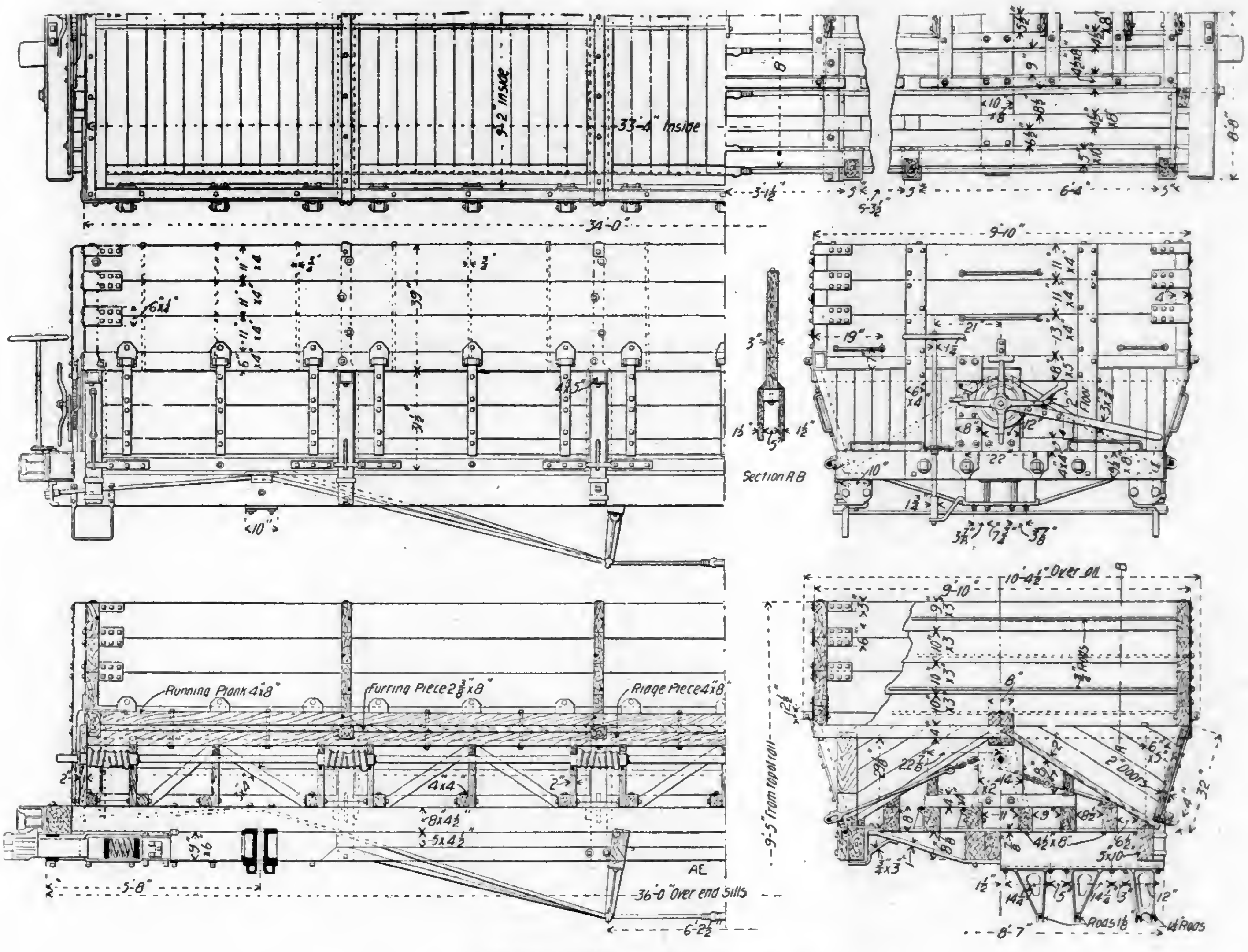
Mr. F. H. Stark, Master Car Builder of the Cleveland, Lorain & Wheeling Railway, has kindly sent us drawings from which 50 side-dump cars of 80,000 lbs. capacity were built for that road six months ago. This road has a heavy coal and ore traffic, the coal going north and the ore south. The cars were designed for this service, and it was considered advisable to make them of the side-dumping type, because for a certain portion of the year they will be used for roadway and track service for hauling gravel for ballasting. This work cannot be as well performed with cars having hopper bottoms. Their weight is increased by this construction, but it was probably considered better to build cars weighing about 41,000 lbs. and use them all the time than to invest so much money in special ballast cars which would not be used for other purposes. These cars have a capacity of 1,450 cubic feet and they carry about 83,000 lbs. of run-of-mine or lump coal when the load is rounded up at the center. The construction provides for carrying most of the load on the side sills. The structure gives substantial support to the floor, as will be seen in the engravings on the opposite page.

The side sills are 5 x 10 in. and the intermediate sills, of which there are six, are 4½ x 8 in., and are placed on top of the bolsters. The box is divided into five separate sections, each about 6 ft. 4 in. long. The floor is supported at the side sills and, at the center of the car, by a 4 x 8 in. ridge piece which rests at the center of each section upon a 2 x 14 in. strut located and supported as shown in the longitudinal and transverse sections. The struts are braced in both directions, fore and aft, and the structure under the floor is continuous for each section. At the spaces between the doors short 5 x 6 in. side stakes are secured to the side sills and upon the tops of these side stakes 4 x 5 in. cross braces rest. These extend across the car and upon them 3-in. partitions are built between the sides of the main body of the box as shown in section at A—B. The other floor supports are shown in the cross section.

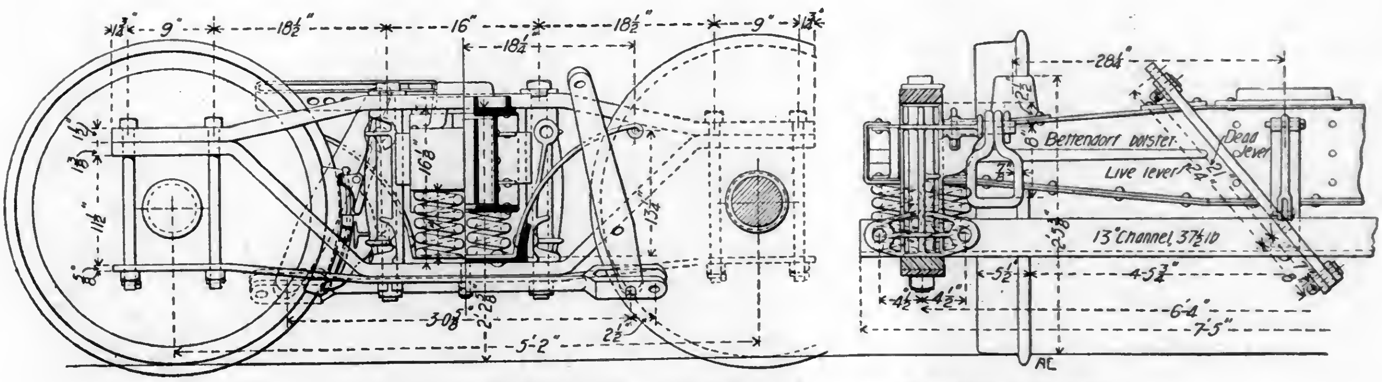
The car has 8 truss rods, four of which are at the side sills where they are most needed. These are 1¼ in. rods giving a depth of 27 in. to the trusses. These could not be deeper and clear the floor. The intermediate truss rods are 1¼ in. and give trusses 34 in. deep. In many side-dump cars difficulty has developed in holding the truss rods at the side sills. Mr. Stark has placed substantial forgings over the ends of the side sills in this design to avoid this trouble. The draft timbers are 6 x 9 in. and the twin-spring draft gear standard for this road is placed between them. The doors are operated from the ends of the car. The operating chains and rods are placed in the spaces between the sections, the short posts already referred to, being cut to pass the rods. The doors are all operated simultaneously by a horizontal shaft having at one end a large star wheel with locking devices. The chief dimensions of the car are as follows:

Length over end sills	36 ft.
Length inside	33 ft. 4 in.
Width over side sills	8 ft. 7 in.
Width of bottom at needle beams	8 ft. 7 in.
Width inside at top	9 ft. 2 in.
Height from rail to top of box	9 ft. 5 in.
Weight, empty	41,000 lbs.
Cubic capacity	1,450 cu. ft.
Nominal capacity, coal	80,000 lbs.
Actual capacity, coal	83,000 lbs.
Side sills, section	5 by 10 in.
Intermediate sills, section	4½ by 8 in.
End sills, section	8 by 9 in.

The trucks are the standard, diamond type, used by this road for 40-ton cars. They have Bettendorf bolsters and roller side bearings, the latter were supplied by the Chicago Railway Equipment Co.



80,000-Pound Side Dump Cars.
For Coal, Ore and Ballast—Cleveland, Lorain & Wheeling Railway



Standard Truck for 80,000-Pound Cars—Cleveland, Lorain & Wheeling Railway.

The Manhattan Elevated of New York has officially decided to use the third rail system in changing from steam to electric traction. Two motor cars will be used on each train of six cars, one at each end, and each motor car will have two motors. The work of constructing the enormous power plant at 74th street and East River has been started, and the Allis works in Milwaukee will begin to deliver the machinery early in September. The engine contract is for over $3,000,000. The dimensions of the power house are 425 by 200 ft.

The rapid acceleration as well as high speeds reached by automobiles is somewhat startling. We are told by Prof. Hele-Shaw in a paper before the Institution of Mechanical Engineers (England) of an average speed of 65 miles per hour. He says: "The extraordinary nature of these results lies not so much in the fact of a high speed of 65 miles an hour by a motor vehicle but in the fact that, starting from rest, the average speed for the first kilometer was 46½ miles an hour." He was describing recent motor carriage trials in France.

WIDE FIREBOX 10-WHEEL PASSENGER LOCOMOTIVES.

Delaware, Lackawanna & Western Railroad.

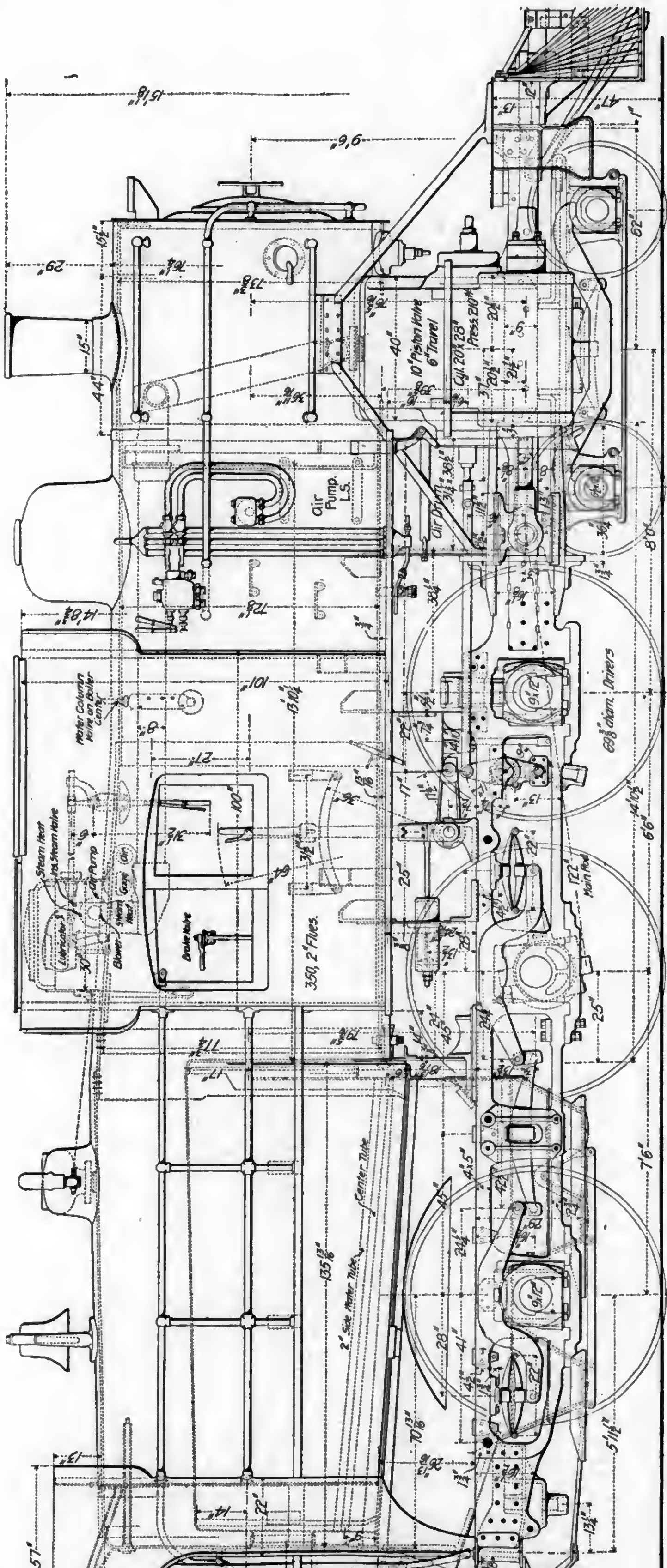
The Heaviest Passenger Locomotives.

The new 10-wheel passenger locomotives recently built by the Brooks Locomotive Works for the Delaware, Lackawanna & Western are the heaviest passenger locomotives ever built. They are powerful and are reported to be giving excellent service. Their greatest interest to us, however, centers in the combination of the 10-wheel type with a firebox having 84.2 sq. ft. of grate area, the diameter of the drivers being 69⅝ in. In view of the difficulties in getting the firebox above the driving wheels the design was worked out very skilfully. The throat is, of course, shallow, and to increase the vertical distance from the fire to the flues at the front end of the grate the tubes were not brought down as low as usual in the tube sheet, the distance from the underside of the lowest flues to the sheet being about 7½ in. The boiler is 72 in. in diameter, which is the largest of which we have record for this type. Its center is the very unusual height of 9 ft. 6 in. above the rails. The firebox sides are straight at the bottom running into easy curves which should prove beneficial to the stay bolts. There is no combustion chamber.

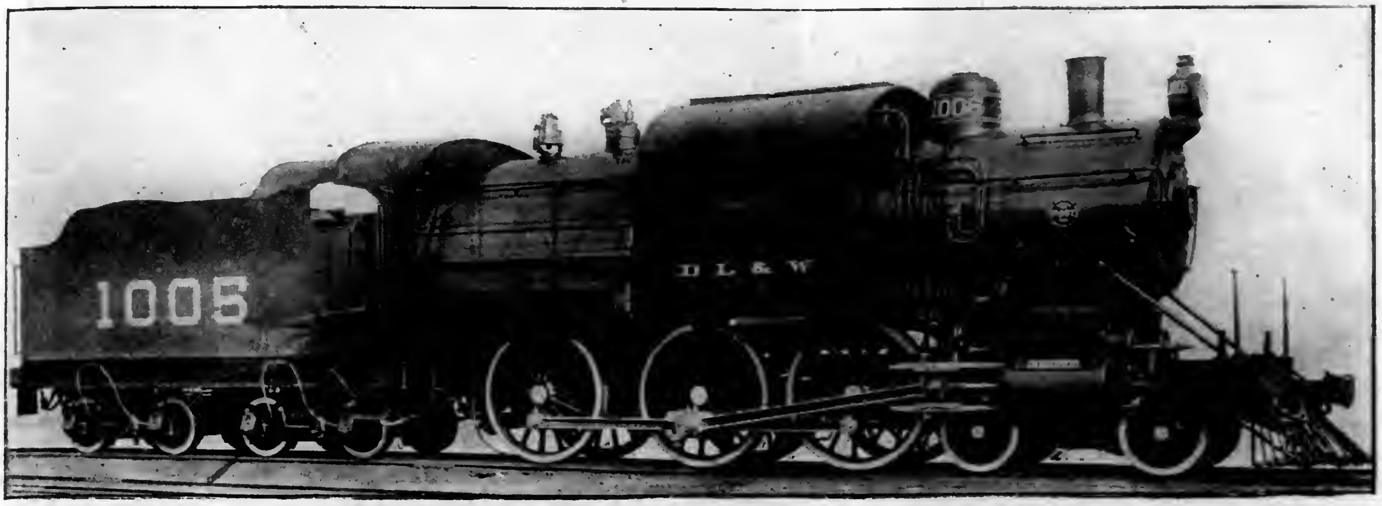
Until the appearance of these engines the Lake Shore engines, of the same type and by the same builders (American Engineer, November, 1899, p. 343), were the heaviest in passenger service. The Lake Shore engines have 217 sq. ft. more heating surface with boilers 6 in. smaller in diameter and 7,400 lbs. less total weight. The D., L. & W. engines probably, however, have an advantage in boiler capacity because of the very large grates.

Among the details the following are noticed: large driving journals, 6½ by 12-in. truck journals, truck brakes, driving brake shoes behind the wheels, the Brooks method of equalizing across the engine at the forward drivers, extended piston rods 4 in. in diameter, enlarged wheel seats for the main crank pins, 10-in. piston valves, diagonal braces from the smokebox to the guide yokes, the steam dome placed in the cab and a short "front end."

This design is considered timely; it is not strange that wide fireboxes should be used on the D., L. & W., but the combination of the wide firebox and 70-in. wheels in a 10-wheel engine is decidedly encouraging to those who would like to use wide grates on heavy passenger engines with bituminous coal. Fine anthracite is used on these engines, but we believe that a similar arrangement with a smaller grate would work out nicely for soft coal. The lack of depth of the firebox under the tubes might be compensated for by additional length. There is much in this design that is suggestive for soft coal burners. The following table supplements the description.



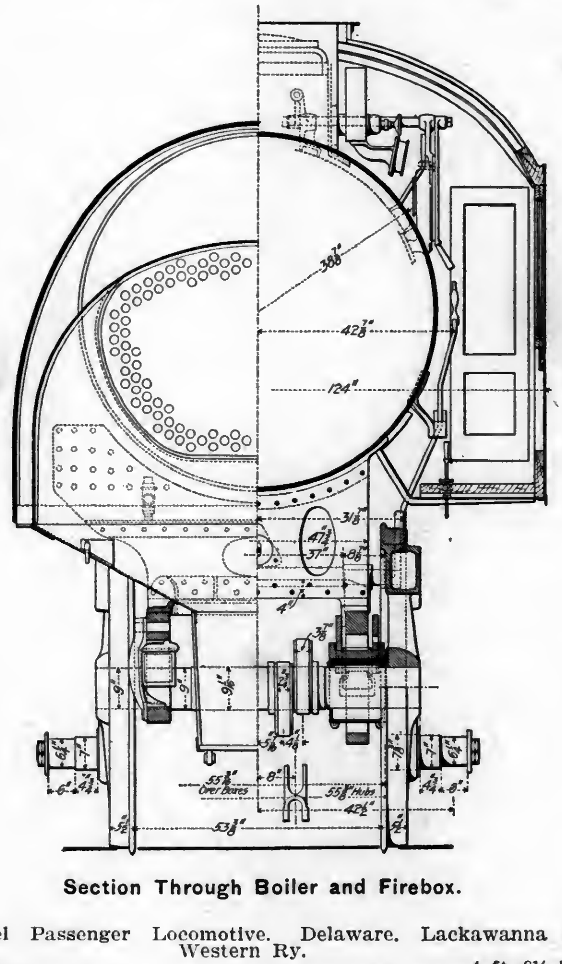
Ten-Wheel Passenger Locomotive—Delaware, Lackawanna & Western Railroad.



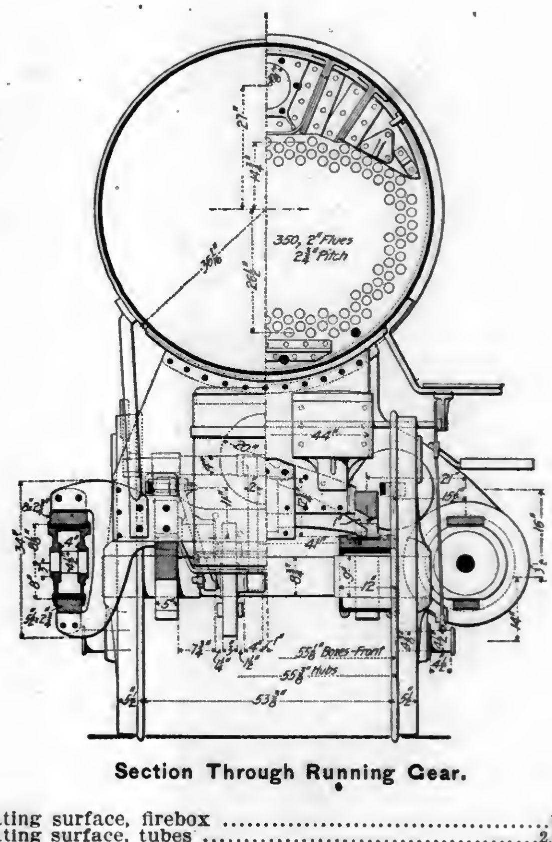
TEN-WHEEL PASSENGER LOCOMOTIVE, WITH WIDE FIREBOX.

DELAWARE, LACKAWANNA & WESTERN R. R. — BROOKS LOCOMOTIVE WORKS, *Builders*.

Weights: Total of engine............179,000 lbs.; on drivers..... 137,000 lbs.; total, engine and tender, 299,000 lbs.
Wheel base: Driving..........14 ft.; total of engine........ 25 ft. 3 in.; total, engine and tender............50 ft. 10¼ in.
Cylinders: 20 x 28 in. Wheels: Driving ....69⅜ in.; truck ....36 in.; tender............ 33 in.
Boiler: Diameter...........72⅛ in.; boiler pressure...... 210 lbs.
Firebox: Length ....127 in.; width ....97 in.; depth, front ...... 61 in.; depth, back...........50 in.
Grate: Water tube; grate area.... 84 sq. ft.; Tubes: Number 350; diameter..... 2 in.; length....... 13 ft. 10¼ in.
Heating surface. Tubes 2,520 sq. ft.; firebox............180 sq. ft.; total ....2,700 sq. ft.
Tender: Eight-wheel; water capacity............6,000 gals.; coal capacity............12 tons.



Section Through Boiler and Firebox.



Section Through Running Gear.

Ten-Wheel Passenger Locomotive. Delaware, Lackawanna & Western Ry.

Gauge ....4 ft. 8½ in.
Kind of fuel to be used..........Fine anthracite coal
Weight on drivers ....137,000 lbs.
Weight on trucks ....42,000 lbs.
Weight, total ....179,000 lbs.
Weight tender, loaded ....120,000 lbs.

General Dimensions.

Wheel base, total, of engine..........25 ft. 3 in.
Wheel base, driving ....14 ft. 0 in.
Wheel base, total, engine and tender..........50 ft. 10¼ in.
Length over all, engine..........38 ft. ¾ in.
Length over all, total, engine and tender..........60 ft. 10¾ in.
Height, center of boiler above rails..........9 ft. 6 in.
Height of stack above rails..........15 ft. 1⅛ in.

Heating surface, firebox ....180 sq. ft.
Heating surface, tubes ....2,520 sq. ft.
Heating surface, total ....2,700 sq. ft.
Grate area ....84.2 sq. ft.

Wheels and Journals.

Drivers, diameter ....69⅜ in.
Drivers, material of centers ....Cast steel
Truck wheels, diameter ....36 in.
Journals, driving axle ....9 in. by 12 in.
Journals, driving axle wheel fit..........9 in.
Journals, truck axle..........6½ in. by 12 in.
Journals, truck axle wheel fit..........6⅞ in.
Main crank pin, size..........6¼ in. by 6 in.
Main coupling pin, size..........7 in. by 4¾ in.
Main pin, diameter wheel fit..........7⅞ in.

Cylinders.

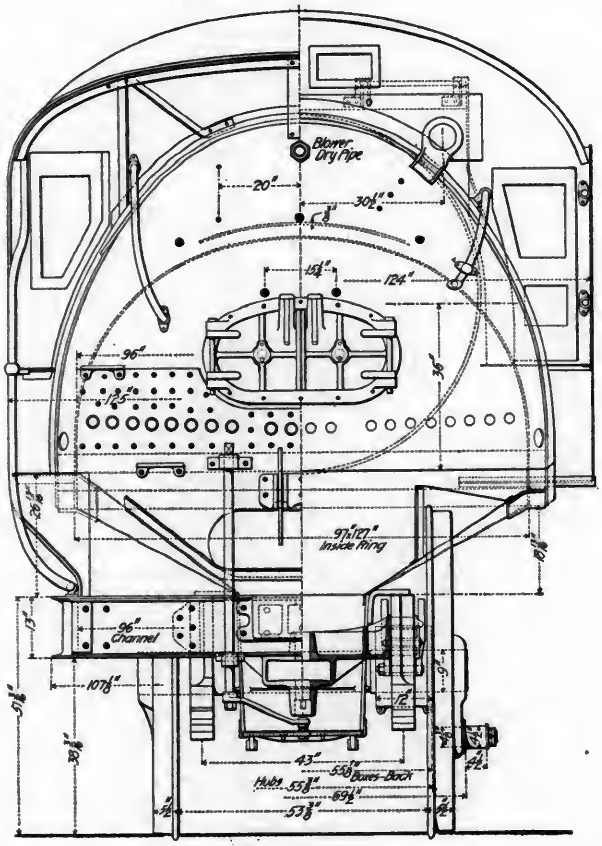
Cylinders, diameter	20 in.
Cylinders, stroke	28 in.
Piston rod, diameter	4 in.
Main rod, length center to center	122 in.
Steam ports, length	20½ in.
Steam ports, width	2 in.
Exhaust ports, least area	75 sq. in.
Bridge, width	3¼ in.

Valves.

Valves, kind of	Improved piston
Valves, greatest travel	6 in.
Valves, steam lap (inside)	1 1/16 in.
Valves, exhaust clearance (outside)	1/16 in.
Lead in full gear	1/16 in. negative

Boiler.

Boiler, type of	Conical connection wagon top
Boiler, working steam pressure	210 lbs.
Boiler, material in barrel	Steel
Boiler, thickness of material in shell	¾ in., 13/16 in., ¾ in., ⅝ in., 9/16 in.
Boiler, thickness of tube sheet	¾ in.
Boiler, diameter of barrel, front	72⅛ in.
Boiler, diameter of barrel at throat	77¾ in.
Boiler, height at back head	75 in.
Seams, kind of horizontal	Sextuple lap
Seams, kind of circumferential	Triple lap
Crown sheet, stayed with	Radial stays
Dome, diameter inside	30 in.



Rear View.

Firebox.

Firebox, type	Wide, over wheels
Firebox, length	127 in.
Firebox, width	97 in.
Firebox, depth, front	61 in.
Firebox, depth, back	50 in.
Firebox material	Steel
Firebox, thickness of sheets	Crown, ⅜ in.; tube, ⅝ in., side and back, ⅜ in.
Firebox, brick arch	None
Firebox mud ring, width	Back and sides, 3½ in.; front 4 in.
Firebox, water space at top	Back, 4½ in.; front, 4 in.
Grates, kind of	Water tube
Tubes, number of	350
Tubes, material	Charcoal iron
Tubes, outside diameter	2 in.
Tubes, length over tube sheets	13 ft. 10¼ in.

Smokebox.

Smokebox, diameter outside	73⅜ in.
Smokebox, length from flue sheet	68 in.

Other Parts.

Exhaust nozzle	Single
Exhaust nozzle, variable or permanent	Permanent
Exhaust nozzle, diameter	4⅞ in., 5 in., 5⅛ in.
Exhaust nozzle, distance of tip below center of boiler	1 13/16 in.
Netting, wire or plate	Plate
Netting, size of mesh or perforation	3/16 in. by 1½ in.
Stack, straight or taper	Steel, taper
Stack, least diameter	14¾ in.
Stack, greatest diameter	16⅝ in.
Stack, height above smokebox	29 in.

Tender.

Type	8-Wheeled
Tank, type	"U" shape, with gravity slide
Tank, capacity for water	6,000 gal.
Tank, capacity for coal	12 tons
Tank, material	Steel
Tank, thickness of sheets	¼ in.
Type of under frame	Brooks 13 in. steel channel
Type of truck	Brooks 100,000 lbs.
Type of springs	Triplicate elliptic
Diameter of wheels	33 in.
Diameter and length of journals	5 in. by 9 in.
Distance between centers of journals	5 ft. 5 in.
Diameter of wheel fit on axle	6⅝ in.
Diameter of center of axle	5⅝ in.
Length of tender over bumper beams	21 ft. 0 in.
Length of tank, inside	19 ft. 6 in.
Width of tank, inside	10 ft. 0 in.
Height of tank, not including collar	60 in.
Type of draw gear	M. C. B. Gould

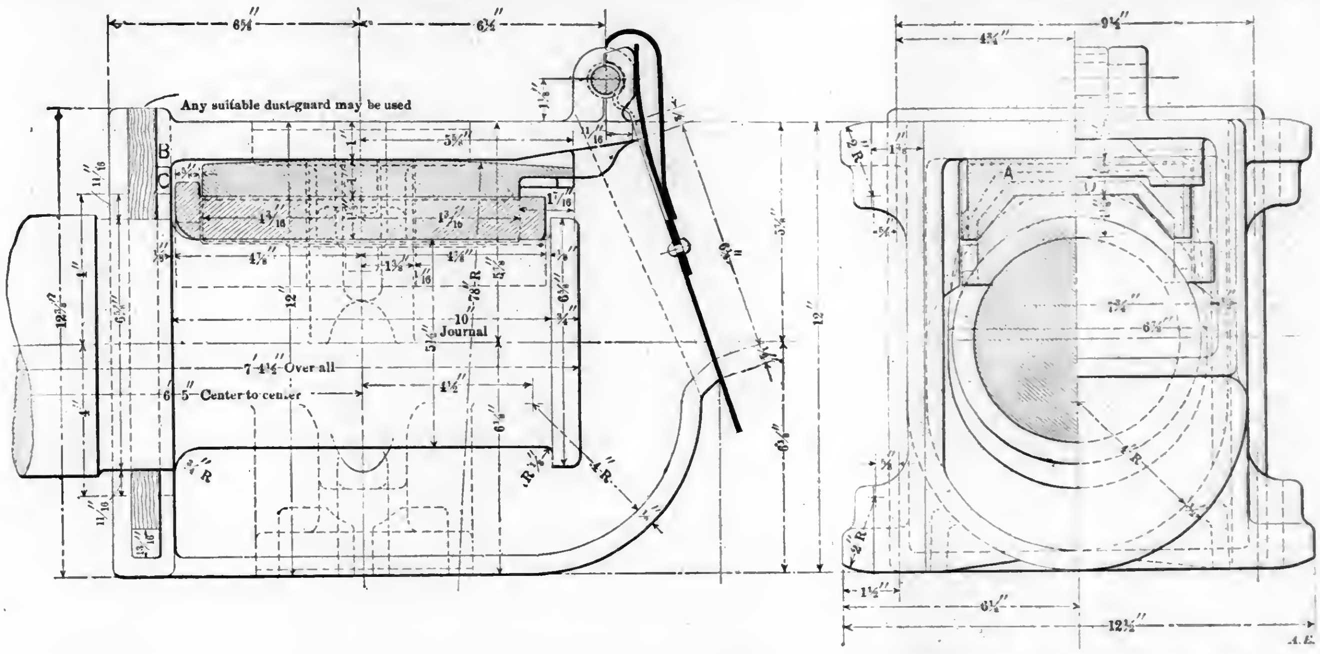
M. C. B. BRAKE SHOE TESTS.

At the last convention of the M. C. B. Association the standing committee on tests of brake shoes was instructed to test such brake shoes which have made sufficient departure from those previously tested to affect their efficiency or durability, as should be presented to it by railway companies who are members of the Association, the committee to indicate such times during the year as it intends to make these tests.

The committee will make tests of brake shoes during the month of March, 1901, and if it is the desire of the railroads represented in the Association to have brake shoes tested, they should communicate with the chairman of the committee as early as possible, so that arrangements can be made for the tests. Communications should be addressed to Mr. S. P. Bush, Superintendent of Motive Power, C., M. & St. P. Ry., West Milwaukee, Wis.

The form of packing for piston valves has been studied by many able men with a view of using wide rings to secure good wearing areas, and at the same time prevent steam pressure from getting under the rings and forcing them out against the bushings, causing excessive frictional resistance. The report of the Master Mechanics' Association committee on piston valves (see page 267 of our August number) closes with the following positive expression: "The committee finds a great variety of packing used for piston valves. It can be said, however, with perfect certainty, that plain snap packing rings will give entirely satisfactory service."

The work on the new shops of the Chicago & Northwestern, at Chicago, which was delayed somewhat this spring on account of labor troubles, has since resumed an active appearance and the enlarged plant will probably be ready for operation by the first of November. The two new buildings of the car department are finished and the three new buildings and an addition to the tank shop of the locomotive department are nearly ready. The boiler shop, which is to take care of the repairs on 1,185 locomotives, is being equipped with its machinery. The cranes are up and the electrical installation completed. The tank shop, which is being lengthened 144 feet, and the walls raised to a height of about 25 feet, will require several weeks for completion. This shop, as stated in the general description of these improvements which appeared in the April issue of this paper, page 109, has received unusual attention and will be a very well arranged department. The two buildings requiring the greatest amount of interior work are the power house and machine shop annex. The floors of this annex are receiving the finishing touches prior to the placing of machines. In the power house the boilers have all had fires under them and the engines, generators, compressor and pumps are all in place, but with the exception of the steel work the floors are not laid. There will be a necessary delay in the completion of these floors as they are to be of tile and cannot be laid to advantage until all of the piping is in place.



N. B. Total lateral (extreme positions of axle) equals ⅜"

A Criticism on the Proposed 5½ by 10 M. C. B. Journal Box.

THE PROPOSED 5½ BY 10 M. C. B. JOURNAL BOX.

By F. M. Whyte.

Mechanical Engineer New York Central & Hudson River Railroad.

When the report of the committee of the Master Car Builders' Association, appointed to recommend a journal box suitable for a 5½ by 10-in. journal, was opened for discussion at the Saratoga convention, question was raised concerning some of the dimensions and also concerning the gages; the objections were not presented clearly and probably, therefore, were not understood. The criticisms seem of sufficient importance to justify calling attention to them again.

The criticism on the box is that provision has not been made for sufficient clearance between the inside end of the bearing and the back wall of the box. With every part in its normal position, the end of the bearing is ⅛ in. away from the back wall of the box, but as there is, in the same normal position, 1/16 in. between the lug on the bearing and the lug on the box there is only 1/16 in. clearance between the end of the bearing and the back wall of the box when the lugs on the bearing and those on the box are in contact. This 1/16-in. clearance is ample, but with rough castings, and not gaged, for the box and bearing this amount is not insured if the dimensions and design presented by the committee are followed. The clearance is the same as allowed in the smaller M. C. B. boxes and it might be reasoned that no more is needed in the 5½ by 10 box, but the error may be in not considering the difference in the loads carried, and that the opening in the 3¾ by 7 box is larger than the end of the bearing; it is possible that if the smaller bearings strike the walls of the boxes in which they are placed the blow is not sufficient to break the box. It is certain, however, that the back walls of 5 by 9 and of 5½ by 10 boxes have been broken in considerable numbers, and in every case with which we are familiar every appearance would indicate that the end of the bearing struck the wall before the lugs on the bearing and box engaged.

A criticism without suggesting a correction would be hardly justifiable and therefore a correction is offered. It is appreciated that a change in the axle, by increasing its length at least, is not to be considered, also that neither the dust guard space nor the thickness of the inner and outer walls should be decreased, there remains, therefore, only the alternative of cutting out such part of the inner wall as can be, in the present design, struck by the bearing. This can be accomplished by changing the box as would be indicated by substituting the line A, in the cross-section of the accompanying engraving, for the line D, and the line B, in the longitudinal section, for the line C. This change would not affect the strength of the box materially. These drawings are reproduced from the report.

The same change could be made advantageously in the 4¼ by 8 and the 5 by 9 boxes.

Standard gages have been provided for the bearing, but if more clearance is not allowed between the end of the bearing and the back wall of the box for the three largest boxes, then the gages for the bearings are not as complete as they should be, inasmuch as there is no gage for the distance from the face of the lug to the outer face of the collar. A gage is provided for the distance from the face of the lug to the inside face of the collar, but the bearing may pass this gage and all of the other gages and the collar be of such thickness as to allow the bearing to strike the back wall of the box before the lugs on the bearing and box engage, even though the box is made exactly to dimensions. If the boxes are cut out in the back wall so that they cannot foul the bearings the present gages for the bearings are sufficiently complete.

While referring to gages it may be profitable to urge the necessity of adopting suitable gages for the boxes; such gages will necessarily be complicated, but they are certainly needed. The relation of the inside lugs to each other and to the holes for the box bolts or the pedestal flanges and the angle which the holes on the pedestal flanges and the sides of the box make with the key-bearing face should be covered. Some boxes are made from patterns and core-boxes parted in a vertical plane which includes the longitudinal axis, and the possibility of producing twisted castings from such patterns is the extreme.

Proofs of Mr. Whyte's criticism were sent to several railroad officers, and the following replies have been received:

To the Editor:

I have read Mr. F. M. Whyte's criticism on the proposed 5½ by 10-in. journal box. As Mr. Whyte acknowledges in his remarks, the box, if perfectly made, has sufficient clearance between the bearing and back of box at all times, or in other words, it is impossible to get the end of the bearing nearer than

to have a clearance of 1/16 in. between it and the box, and the only trouble that could arise would be on account of poor workmanship in making the boxes. This is a point the committee considered and concluded that, like all other parts of the box that have a direct bearing on the wedge and brass, it was the duty of the purchaser to see that they were correct, and if they were correct there would be no danger of being broken by the bearing.

In further comment on the criticism the committee brought the subject before the users of some twenty thousand 100,000-lb. cars, which included about all the cars of this capacity in use. The replies, without exception, indicated there was no trouble with the box in use, which has the same clearance as submitted on the drawings. It was therefore decided to submit the plan as shown, believing it would meet all the requiremnts for which it was designed. W. GARSTANG,
Supt. Motive Power, C., C., C. & St. L. Ry.

Indianapolis, Ind.
To the Editor:

I think the criticisms of Mr. Whyte are well taken. While it is true that there is sufficient clearance if the castings are perfect, it is almost impossible to get perfect rough castings. A clearance of 1/16 in. in rough castings is insufficient.

I have, however, obviated this difficulty in a box made here by making the back wall 3/32 in. thinner and making the box of malleable iron instead of gray iron.

There is another way to accomplish the same result, and I believe it would be preferable, and that is to set back the outside face of the hub of the wheel ⅛ in. and add this to the inside of the hub; then make the box ⅛ in. longer than is now shown. "CAR BUILDER."

TEN-WHEEL PASSENGER AND FREIGHT LOCOMOTIVES.

Chicago, Rock Island & Pacific Railway.

Vauclain Compound Type.

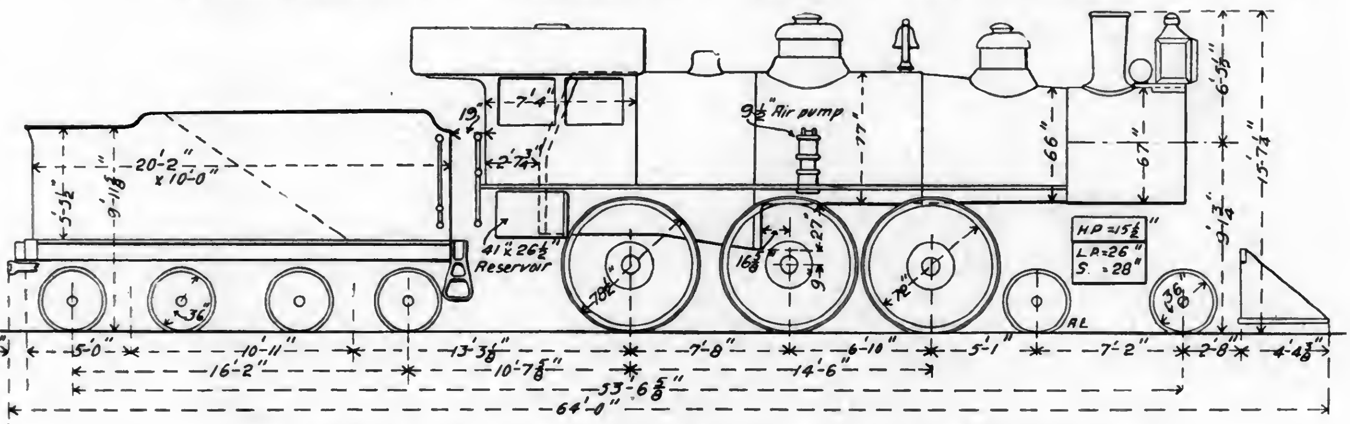
This road has been exceedingly conservative on the compound locomotive question, and the interest in these locomotives centers in the fact that the increase in weight and speeds of trains resulted in a trial of the compound as a relief measure because the endurance of firemen had been very nearly reached with the simple engine. There was also a desire to economize in fuel, but it is understood that the fast and heavy trains necessitated such large capacity in a simple engine as to render it difficult to supply sufficient steam. When adopted after such a careful policy and under such conditions, the compound has an exceedingly favorable opportunity to show what it can do, and we are informed that the firemen are greatly pleased with them and that they are known to be saving coal, although no extravagant claims are made. Mr. Wilson appeared to our representative to be enthusiastic about them.

The passenger service of this road includes fast trains of 12 cars, with a total weight of 1,103,000 lbs. While the large eight-wheel engines used in the same service were able to handle these trains on schedule, it was not easy to make up time, and the weights of the trains could not be reduced. Two Vauclain passenger engines were ordered and these did such good work that three more were ordered, and also three freight engines, making a total of 17 freight and 5 passenger engines.

TEN-WHEEL VAUCLAIN COMPOUND PASSENGER LOCOMOTIVE.

CHICAGO, ROCK ISLAND & PACIFIC RAILWAY. BALDWIN LOCOMOTIVE WORKS, *Builders*.

Weights: Total of engine............179,295 lbs.; on drivers............134,560 lbs.; total engine and tender......... 289.000 lbs.
Wheel base: Driving........14 ft. 6 in.; total of engine........ 26 ft. 9 in.; total engine and tender............53 ft. 6 in.
Cylinders: 15½ and 26x28 in. Wheels: Driving..........78½ in.; truck.... 36 in.
Firebox: Length............118 in.; width............40⅛ in.; depth front........79½ in.; width, back............67 in.
Grate: Area.... 32.8 sq. ft. Tubes: Number ....329; diameter .... 2 in.; length.... 15 ft.
Heating surface: Tubes...........2,569 sq. ft.; firebox......... 180.5 sq. ft.; total ....2,750 sq. ft.
Tender: eight-wheel.; Tank capacity............5,500 gals.; coal...........10 tons.



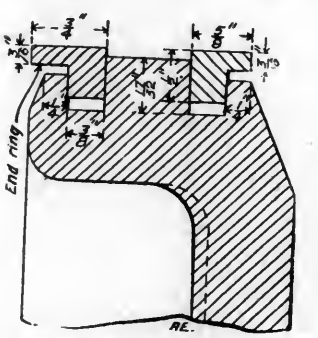
Outline Diagram of Ten-Wheel Locomotives—Chicago, Rock Island & Pacific Railway.

These freight engines are of the same type and dimensions, except as to the wheels and weights. The passenger engines have 78 in. drivers and 36 in. engine truck wheels and the freight have 57¾ in. drivers and 30 in. truck wheels. The weights are as follows:

	Total.	On drivers.	On trucks.
Passenger	179,275 lbs.	134,560 lbs.	44,715 lbs.
Freight	173,015 lbs.	130,150 lbs.	42,865 lbs.

The small diagram shows the sloping form of the back boiler head. The effect of this practice, which has been in successful use on other roads, notably the Pennsylvania, is to lighten the back end of the engine, give more room in the cab and render the firebox heating surface more effective. The flames appear to follow the back sheet closely, and Mr. Wilson has noted an increase in the temperature of the cab over that of the usual construction, which will necessitate lagging the back head. This seems to be excellent evidence of improved circulation at the back end of the firebox.

Considerable thought and care have been put into the cab arrangement and the tender hand-holds and steps, with a view of increasing the safety and comfort of the men. The lighting of the engine is by electricity, from curent furnished by a steam turbine located back of the headlight on the smokebox. Lights are placed under the running board for the benefit of the engineer in oiling and inspecting the machinery. It has been found necessary on this road to guard against the setting of fires by sparks from the ash pans, on account of the peculiar behavior of some of the coals used. This has led to the use of double dampers at both ends of the ash pans, one of the usual plate construction and the other of wire netting. We also show a section through the packing rings of the piston valves to illustrate the overhanging cut-off edges. The chief dimensions are given in the following table received through the courtesy of the builders:



Piston Packing Rings.

Passenger and Freight Locomotives, Chicago, Rock Island & Pacific Ry.

Cylinders.

Diameter (high pressure)	15½ in.
Diameter (low pressure)	26 in.
Stroke	28 in.
Valve	Balanced piston

Boiler.

Diameter	66 in.
Thickness of sheets	11/16 in. and ¾ in.
Working pressure	200 lbs.
Fuel	Soft coal

Firebox.

Material	Steel
Length	118 in.
Width	40⅛ in.
Depth	79½ in. front; 67 in. back
Thickness of sheets	Sides, 5/16 in.; back, ⅜ in.; crown, ⅜ in.; tube, ⅝ in.

Tubes.

Number	329
Diameter	2 in.
Length	15 ft. 0 in.

Heating Surface.

Firebox	180.5 sq. ft.
Tubes	2,569.6 sq. ft.
Total	2,750.1 sq. ft.
Grate area	32.8 sq. ft.

Driving Wheels.

Diameter (outside)	78½ in. passenger; 64¾ in. freight
Diameter of center	72 in. passenger; 57¾ in. freight
Journals	9 in. by 12 in.

Engine Truck Wheels.

Diameter	36 in. passenger; 30 in. freight
Journals	6½ in. by 11 in.

Wheel Base.

Driving	14 ft. 6 in.
Rigid	14 ft. 6 in.
Total engine	26 ft. 9 in.
Total engine and tender	53 ft. 6⅝ in.

Weight.

On drivers	Passenger, 134,560 lbs.; freight, 130,150 lbs.
On truck	Passenger, 44,715 lbs.; freight, 42,865 lbs.
Total engine	Passenger, 179,275 lbs.; freight, 173,015 lbs.

Tender.

Diameter of wheels	36 in. passenger; 33 in. freight
Journals	5 in. by 9 in.
Tank capacity	5,500 gal.

A REMARKABLE IMPROVEMENT IN TOOL STEEL.

For several years it has been rumored that remarkable success was being attained by a new process of hardening tool steel, developed by Mr. F. W. Taylor and Mr. Maunsel White, of Bethlehem, Pa. Recently a representative of this journal saw some samples of enormously heavy chips removed by a tool hardened by this process, the chips being of a brilliant blue color, indicating that they were removed at an exceedingly high temperature, and we are now informed that soft steel is being cut at the previously unheard of speed of 150 ft. per minute. At the Saratoga Conventions Mr. H. F. J. Porter kindly showed our representative samples of chips, which were tagged as follows:

Quality of Steel.	Width of Cut.	Depth of Cut.	Speed in Feet per Minute
.60 carbon.	⅝ to ⅞ in.	7-32	29 ft.
.40 "	3-16 "	1-16	60 ft.
.10 "	3-16 "	1-16	150 ft.
1.05 tool steel.	3-16 "	1-16	15 ft.

This hardening process was developed at the works of the Bethlehem Steel Company in connection with a comprehensive plan carried out by Mr. Taylor for increasing the capacity and improving the operation of the plant. The machine shop at Bethlehem, which is the largest in the country, was six months behind the forge and an increase of capacity by increase of equipment was prohibited by the expense. Finding that a large number of different kinds of tool steel were in use by different workmen on similar work, Mr. Taylor spent a great deal of time in studying the question of tool steel, with the final result of developing this new process and discarding steel made by the others. This process is applied after the tool is forged, and the remarkable property, whereby the hardness of the steel is retained even when heated by the friction of its work up to the point of redness, explains the wonderful results. The penetration of the hardening effect is sufficient to reach the center of a tool 4 in. square, and the interior is put into the same condition as the outside, the result being that a tool made of this steel is good until completely worn out. The method of hardening gives extremely uniform results and it improves the forging qualities. It is understood that the process may be applied to all the standard brands of self-hardening steel and that they are all improved to different degrees by the treatment. The best results, however, are obtained from a specially prepared steel. It is also stated that this special steel can be annealed so that it may be machined into shape for twist drills and inserted cutters.

The Bethlehem Steel Company have revolutionized their practice by this improvement. The old machine tools were found inadequate to carry the cuts which the cutting tools themselves would stand, and it has been necessary to take up a general revision of the shop tools. The main shafting has been speeded up from 90 to 250 revolutions and the general improvement and the possibilities elsewhere are shown in the following table:

Average.	October 15, 1898.	May 11, 1899.	January 15, 1890.	Gain in per cent. cut of third over second.	Gain in per cent. cut of third over first.
Cutting speed	8 ft. 11 in.	21 ft. 9 in.	25 ft. 3 in.	16	183
Depth of cut	0.23 in.	0.278 in.	0.30 in.	8	30
Feed	0.07 in.	0.0657 in.	0.087 in.	32	24
Pounds of metal removed per hour	31.18	81.52	137.3	68	340

Recently an exhibition of the working of the steel was given at the Bethlehem works, and the results are sufficiently remarkable to warrant personal investigation by all whom the use of this improvement would affect.

AUTOMATIC ASH ELEVATOR.

Operated by Pneumatic Power.

Chicago & Northwestern Railway.

Altogether the best arrangement we have seen for handling locomotive ashes and cinders has been designed and built by the Motive Power Department of the Chicago & Northwestern for its various round-houses, two having been recently installed at the new roundhouse at Clinton, Iowa, which is one of its most important division points. At terminals it is necessary to take advantage of every means for "turning" engines as quickly as possible in order to save delay to traffic. This is specially important in busy seasons like the present, and many improvements may be expected in coal and ash handling appliances. These are usually the "slowest" parts of terminal equipments.

The apparatus which we are permitted to illustrate was designed by Mr. G. R. Henderson, Assistant Superintendent of Motive Power, under the direction of his superior, Mr. Robert Quayle. It was arranged with a view of facilitating the handling of ashes and cinders, cheapen these operations, do it with simple apparatus and permit of operating the devices in a way which should not cause a moment's delay to the engine while the ashes are being taken away. This hoist transfers the ashes from the ash pan of the engines directly to the cinder cars without intermediate handling. It is handled by a single operator who does not leave the pit.

The essentials of the apparatus are shown in Fig. 1, the plan and sections of the pit in Fig. 2 and the arrangement of the cylinder and automatic controlling devices in Fig. 3.

The pit is 57 ft. long and of the form shown in Figs. 1 and 2. The loading track is 25 ft. from the center of the pit track and level with it. Over the loading track is a substantial frame of timbers supporting the upper ends of the inclined tracks for the pit buckets. At the lower side of the pit, Fig. 2, is a passage the entire length of the pit, in which are located conveniently for the operator, the three-way valves and locking levers.

When an engine has passed over the pit the two ends of the ash pan correspond with the positions of the small trolleys. After the fire has been cleaned and the ashes and clinkers swept out into the trolleys the three-way cock is opened by the attendant and one of the trolleys is drawn up the incline by the pneumatic cylinder and wire rope, and when it comes into contact with the block at the upper end of the track the bottom is automatically tripped and the ashes dropped into the car. The three-way cock is then reversed and the bucket returned to its original position. The door closes as it passes down the inclined track. A lever, shown in Fig. 2, is then moved by the attendant, locking the first bucket and releasing the second. A repetition of the operation of the three-way cock then raises and dumps the second bucket.

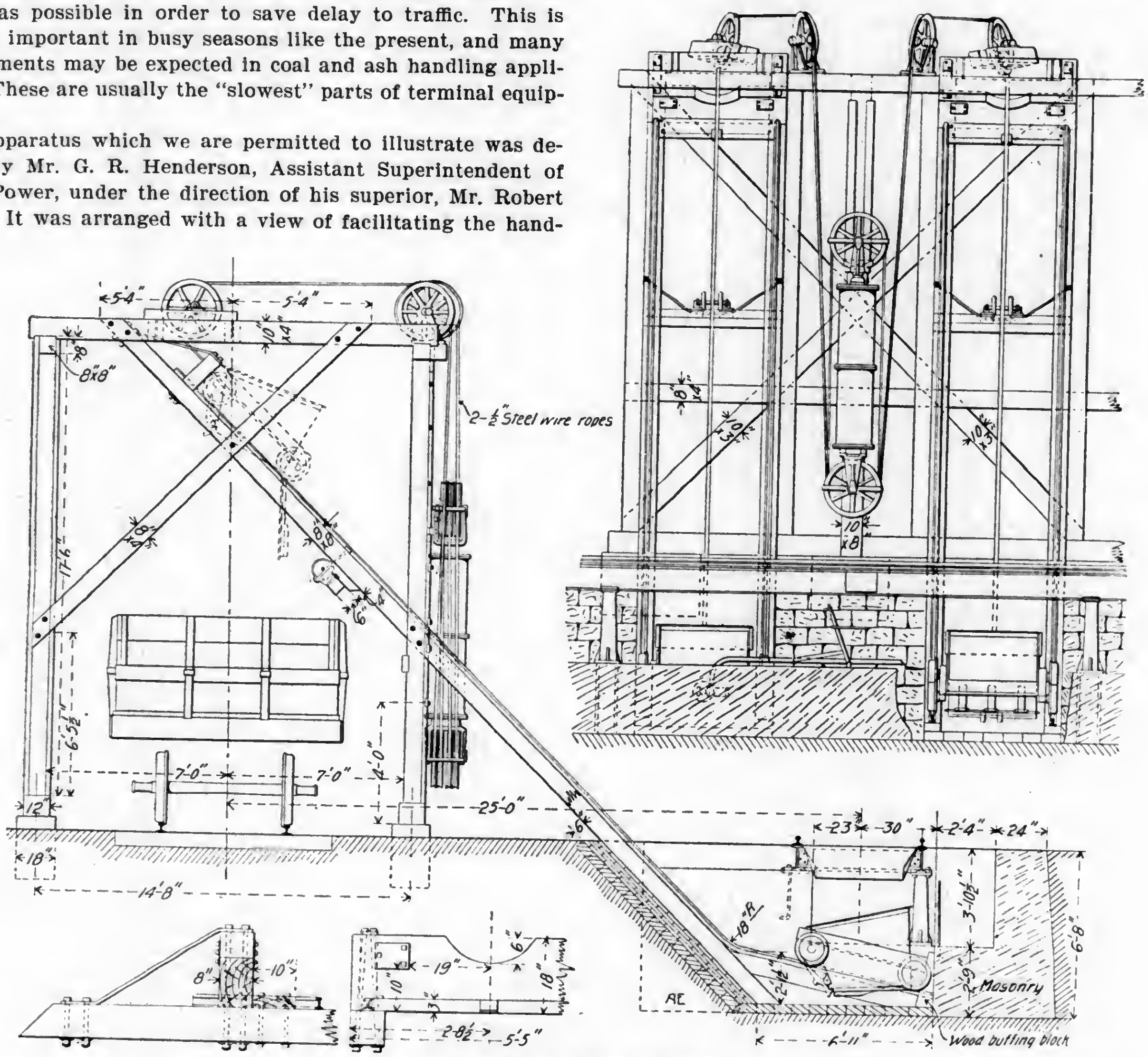


Fig. 1.—General Plan of Hoist.

This plan employs but one cylinder for two buckets, one bucket being used as an anchor, while the other is emptied. The hoist is made double so that the front end and ash pan may be cleaned simultaneously and with the engines heading in either direction. The attendant does not leave the pit, and while the ashes are being dumped the engine may be moved off the pit and another take its place.

Several of the details are worthy of notice, especially the one with the small wheels on the lower side of the trolley track. This closes the door on its descent, the wheels being

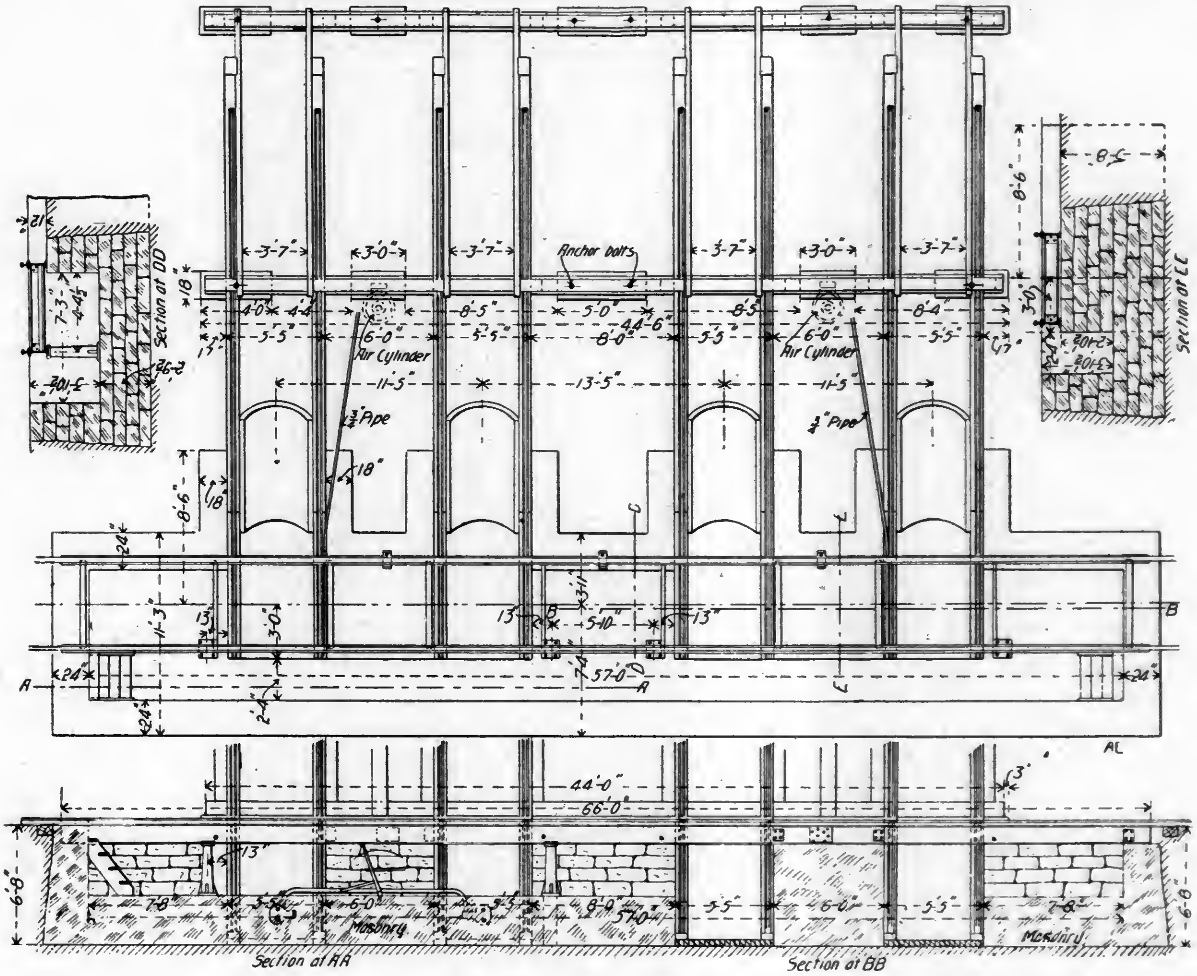


Fig. 2.—Plan of Pit and Frame.

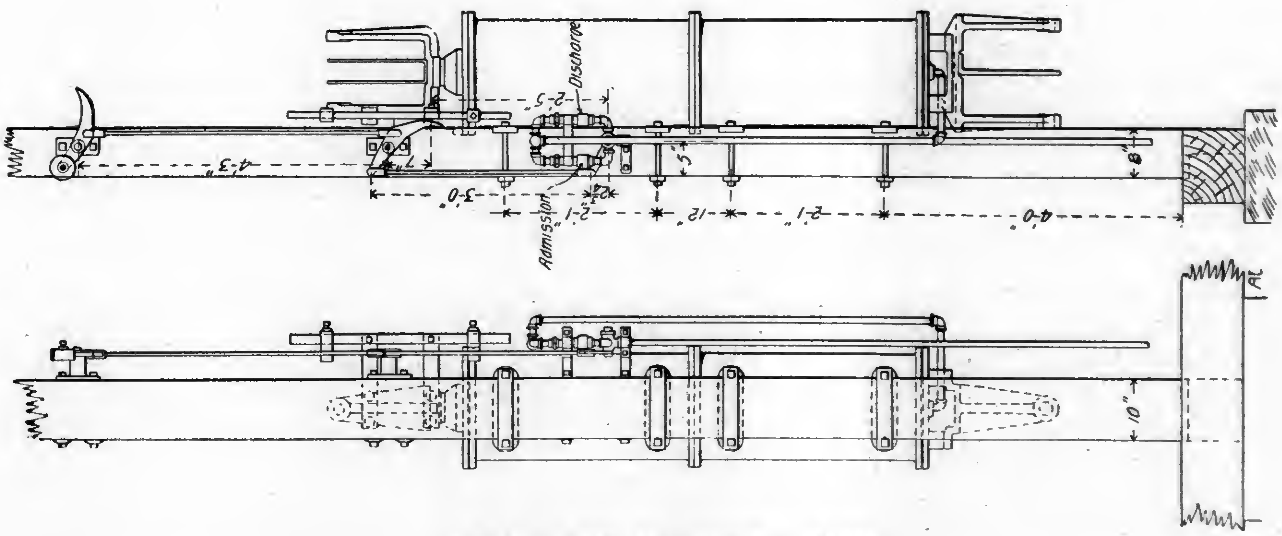


Fig. 3.—Cylinder and Automatic Valves.

arranged so that when struck by the trolley in its upward trip they move out of the way and clear the door without lifting the car. On the descent the door strikes the wheels and it is closed and latched before reaching the pit. Another ingenious feature is the arrangement for controlling the motion of the trolley, preventing it from striking hard at either end of its travel. The three-way cock, at the cylinder in Fig. 3, is actuated by the motion of the piston. When near the end of its stroke it closes the valve opening in the direction in which the air is moving and compels the remainder of the supply to pass through a small hole in the check valve which opens in the opposite direction. In this way the trolley will be brought to the end of its travels gently, even when the bucket is taken up empty. The other details and the construction of the framing and the rigging of the wire rope are plainly shown in the illustrations.

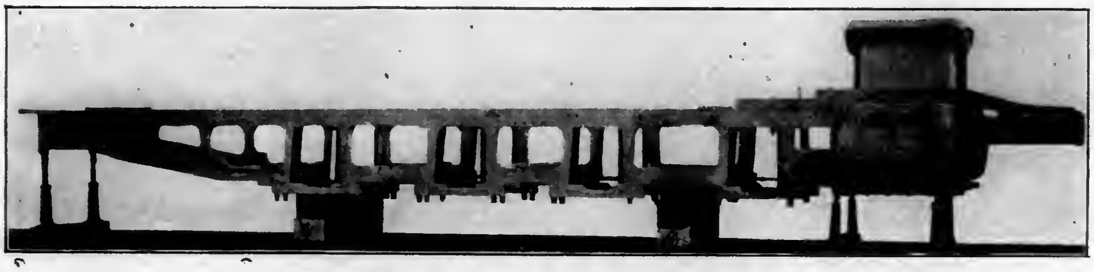
Two of these hoists have been installed at Clinton, Iowa, and the first night, with the men unaccustomed to the apparatus, forty locomotives were cleaned between six o'clock p. m. and seven o'clock the next morning.

WIGHTMAN'S CYLINDER AND FRAME FASTENING.

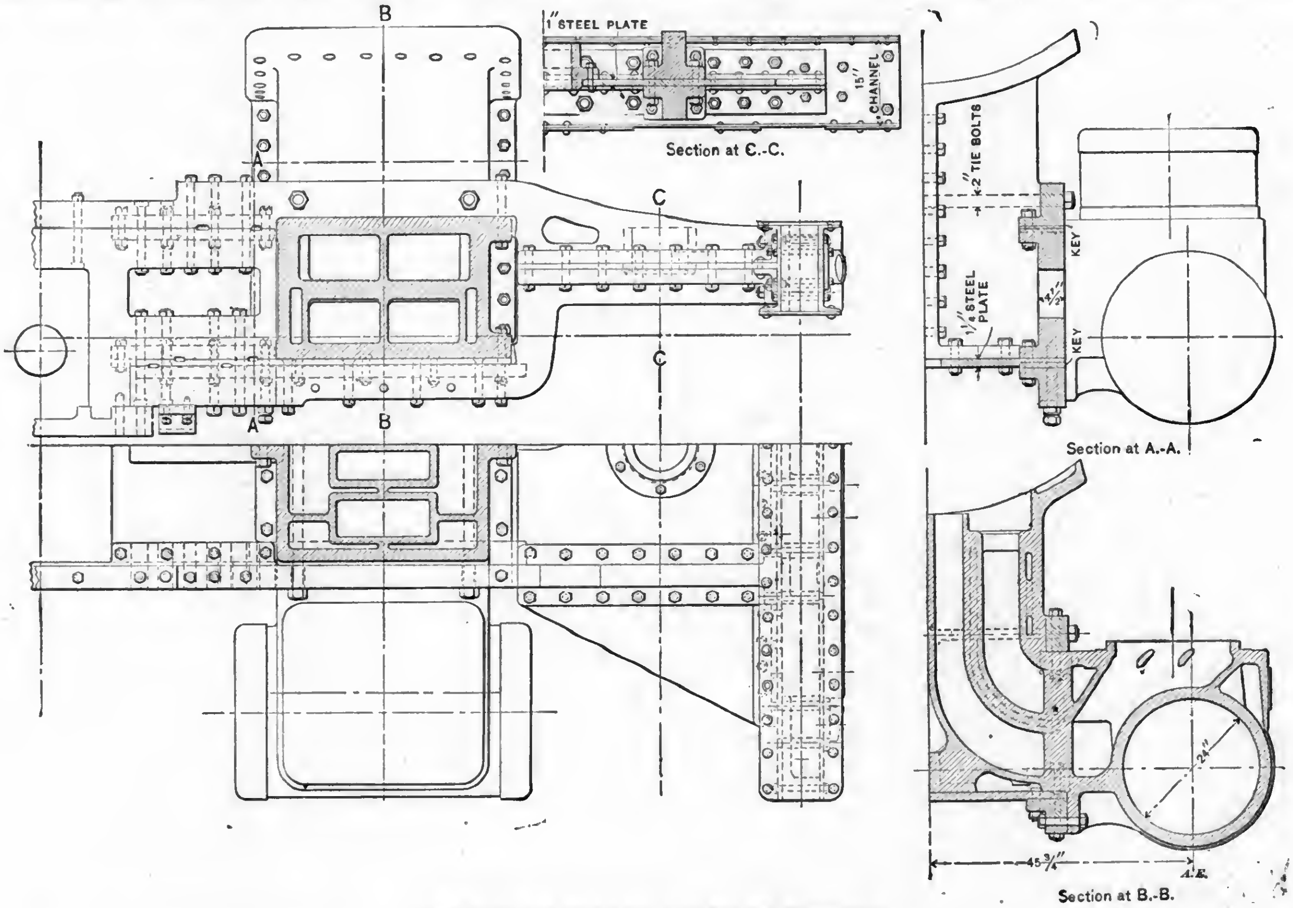
Used by Pittsburgh Locomotive Works on Large Pittsburgh, Bessemer & Lake Erie Locomotives.

To secure sufficient strength of the attachments of cylinders and frames of very large engines has been a difficult problem. The stresses from 24-in. pistons with a boiler pressure of 200 lbs. are enormous, necessitating more careful construction at the front end than has been necessary before. The large engines built by the Pittsburgh Locomotive Works for the Pittsburgh, Bessemer & Lake Erie Railroad, illustrated in our July number, page 214, have a new and very substantial structure between the cylinders and frames and one which we think is stronger and more rigid than any other arrangement we have seen. It was designed especially for these engines and patented by Mr. D. A. Wightman, general manager of the works. The construction is clearly shown in the accompanying engravings which were made from drawings prepared especially for illustration by the Pittsburgh Locomotive Works.

The essential features are a solid abutment of metal at the back end of the cylinder casting, continuous frame support without splices up to the cylinder, large plates across the engine from frame to frame under and back of the cylinders and also in front of them. These plates are one inch thick. One of them reaches from a point even with the front end of the saddle to the first driving box jaw, extending across the engine from frame to frame and securely bolted between the saddle and the frames. This plate is cut out behind the saddle for the front truck equalizer. The other plate secures the frames in front of the saddle and forms the front deck. The front rails are spliced to the main frames back of the saddle. They come together again in front of it and the front plate forms a solid deck and transverse stiffening structure in front of the saddle. It also carries the truck thimble and is secured to the bumper by angles. The engravings show the method of securing the various parts and the sectional views show the angle forms of the frames for giving good bearing area for the bolts. This construction illustrates an advantage possessed by cast steel for such heavy work. These angle forms might be made in forgings but they would be very expensive. Readers will probably notice the heavy tie rods between the upper bars of the frames through the saddle and also the large number of bolts through the splicer and plates.



Photograph of Frames With Cylinders Attached.



Wightman's Cylinder and Frame Fastening.

This construction makes a favorable contrast with practice on some large engines recently built in which the usual form of frames used for much lighter engines has been followed. This plan by Mr. Wightman seems to provide for the large stresses in an admirable way, bringing the resistances to the center of the frame structure and avoiding the usual methods by which the frame splices are subjected to all of the cylinder stresses whether compressive or tensile. With 24-inch cylinders and a pressure of 160 lbs. on the piston from 200 lbs. boiler pressure

the stress on each side will amount to 72,000 lbs. It is evident that a substantial structure is needed to hold up against such work, especially when the stresses will often amount to rapid blows in opposite directions when the engine is slipping. This is believed to be an important and valuable improvement.

ADVANTAGES OF CARS OF LARGE CAPACITY.

Mr. L. F. Loree, General Manager of the Pennsylvania Lines West of Pittsburg, recently presented a valuable report to the International Railway Congress upon the subject of the capacities of freight cars. It appears in the Bulletin of the International Railway Congress, May, 1900, page 941, and in addition to the author's discussion it contains in the form of appendices the most complete record of the dimensions of freight refrigerator and express cars that we have seen. For example, the leading dimensions and weights of 600,000-lb. box cars on 40 different American railroads are given and dimensions of other cars in proportion.

After a review of the development of the present large cars in this country the author takes up the comparative merits of 60,000 and 80,000 lbs. capacity box cars. The following is reproduced from the report and contains an argument by Mr. T. N. Ely, Chief of Motive Power of the Pennsylvania Railroad.

The following table shows the relative weight, capacities and cost of 60,000 and 80,000 lbs. capacity box cars, of which a large number are now being built by the Pennsylvania, Illinois Central and other lines:

Marked Capacity.	Length.	Paying load.	Weight of Body.	Weight of Trucks.	Total Weight.	Lbs. paying load to each lb. dead load.	Cost of car.	Cost per ton of carrying capacity.
60,000	34 ft.	66,000	19,920	12,280	32,200	2.05	$556.35	$16.86
80,000	34 ft.	88,000	20,506	14,694	35,200	2.50	603.95	13.73
Differences.								
20,000	......	22,000	586	2,414	3,000	0.45	$47.60	$3.13

This shows a difference of $47.60 in the cost of the two cars, but the 80,000 lbs. car costs 18.6 per cent. less per pound of carrying capacity than the smaller one.

It is objected that the greater light weight means greater cost of moving the car, but if we analyze the cost of moving the 3,000 lbs. greater weight we have:

Average mileage, box cars per year........................10,000 miles
Average weight, box cars..16 tons
Average paying load..10 tons
Average cost of transporting paying load per ton-mile........4 mills
Cost of moving car and load per mile..............................40 mills
40 mills divided by 26 gives..............................1.54 mills per ton
1½ tons additional dead weight carried 10,000 miles...15,000 ton-miles
15,000 ton-miles × 1.54 mills = $23.10, cost per year to haul the additional dead weight.

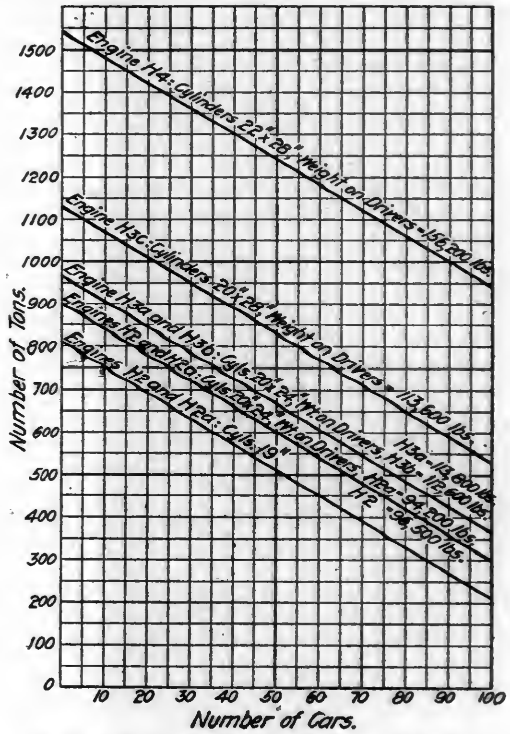
If we assume an average receipt per ton mile of 5.36 mills and the cost as above at 1.54 mills, the net revenue from any additional freight handled in such a car would be 3.82 mills per ton mile, and to pay for the extra cost of moving the extra dead weight we must carry 6,000 tons of paying load, $23.10 = 3.83 mills, and as an 80,000 lbs. car will load at least seven tons more than a 60,000 lbs. car one trip of 857 miles (6,000 ÷ 7) each year, with additional load, would compensate for hauling the extra dead weight of 1½ tons the entire year. (This we understand to be Mr. Ely's argument.—Editor.)

As a matter of fact, these cars can be and have been loaded with 88,000 lbs. of grain at the elevators on the Mississippi River and carried to Baltimore, Philadelphia and New York; the capacity of the yards and terminals is increased 33 1/3 per cent. over that obtained with cars of 60,000 lbs. capacity by the use of the 80,000 lbs. cars.

The large car seems, from a weight-carrying standpoint, in every way desirable for many lines that have special traffic, such as ore, coal, stone, bricks and metal, where the cars can be made to carry full loads in at least one direction. Every railroad of importance in the United States has spent large sums of money in reducing grades, improving alignment and remodeling yards. The weights of locomotives are being constantly increased and to get the greatest earning power from these locomotives and to secure the benefit of the large sums expended in improvements in the road, it is necessary to have cars that will carry the greatest possible load without increasing in length.

There is a very large tonnage of ore and coal handled between the Great Lakes and the furnaces and mines located 150 to 200 miles distant therefrom. The ore is brought from the Lake Superior region in vessels and transported from the various ports of Lake Erie to the furnaces, without being stored at the docks. These vessels a few years ago were of a maximum capacity of from 2,500 to 3,000 tons, but now as much as 8,500 tons are carried in one vessel. Quick dispatch is required on the part of the vessel owner, which under conditions prevailing five years ago would be impossible, but by the use of cars of 100,000 lbs. capacity it has been accomplished, and the railroads are handling a much heavier tonnage over the same tracks, and, notwithstanding the earnings per ton mile have been greatly cut down, they have been able to maintain a margin of profit.

A careful record of nearly 200,000 cars handled on two lines of railway leading from Pittsburgh to two of the principal



Engine Rating—Erie & Ashtabula Division. Pennsylvania Lines West of Pittsburg.

ports of Lake Erie shows that it was possible to secure the following loads for their cars:

Ore ....108% of marked capacity
Coal .... 82% of marked capacity

The following table shows the per cent. of marked capacity averaged for large cars:

Number of cars.	Capacity.	% of capacity carried.
3,616	100,000 lbs.	93
136	80,000 lbs.	94
6,727	70,000 lbs.	97

This proves most conclusively that it was true economy under such conditions to build cars of greater capacity than 60,000 lbs.

To bring out the relative changes in increase of dead weight and paying load and the relation of light to the total loaded weight the following table is presented. The first six items are quoted from Mr. Loree's paper and the last two are added from information kindly furnished us by Mr. C. A. Seley, Me-

chanical Engineer, Norfolk & Western Railway, concerning two cars of large capacity designed by him:

Year.	Dead weight of car in pounds.	Paying load in pounds.	Total loaded weight in pounds.	Per Cent of total. Wt. of car.	Per Cent of total. Paying load.
1876	20,500	20,000	40,500	53.62	42.38
1882	24,000	40,000	64,000	37.50	62.50
1889	27,700	60,000	87,700	31.59	68.41
1895	36,000	80,000	116,000	31.04	68.96
1898	38,500	{ 100,000	138,500	27.80	72.20
		{ 110,000	148,500	25.93	74.07
1899*	39,600	105,000	144,600	27.45	72.6
1900†	32,500	88,000	120,500	27.00	73.0

The last two (composite) cars in this list are not included in Mr. Loree's paper, but they are placed by us in the table because of their high standing with reference to the all-steel cars. These Norfolk & Western cars have wheels weighing 650 lbs. and we believe that at least 1,500 lbs. could be taken off the Norfolk & Western cars without sacrificing strength or endurance. If this is done the gondola car would be a 74 per cent. revenue carrier, a remarkable result under the conditions, which warrants this digression from Mr. Loree's argument.

The advantages gained by reducing the length of trains for a given tonnage which are secured by the use of large capacity cars are:

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Second. A smaller number of cars and locomotives is required to move a given tonnage, saving interest on capital and car service, and lessening the empty car movement in the direction contrary to the heavy traffic movement.

Third. The necessity of increasing the capacity of the main lines, freight yards and shops is avoided, and at the same time the cost of switching is reduced.

Fourth. A large saving in wages results from the decreased number of trains.

These are the reasons for the reduction of the cost per ton mile of hauling freight to figures which were thought to be impossible before the advent of the large car. To illustrate the increase in tonnage which is obtained by decreasing the number of cars in which it is hauled, Mr. Loree prepared the accompanying diagram, which shows the power of various engines on 1 per cent. grades on the Erie & Ashtabula division of the Pennsylvania Lines West of Pittsburg. The diagram also gives the weights and cylinder dimensions of the engines, the rating being based upon a speed of 8 miles per hour.

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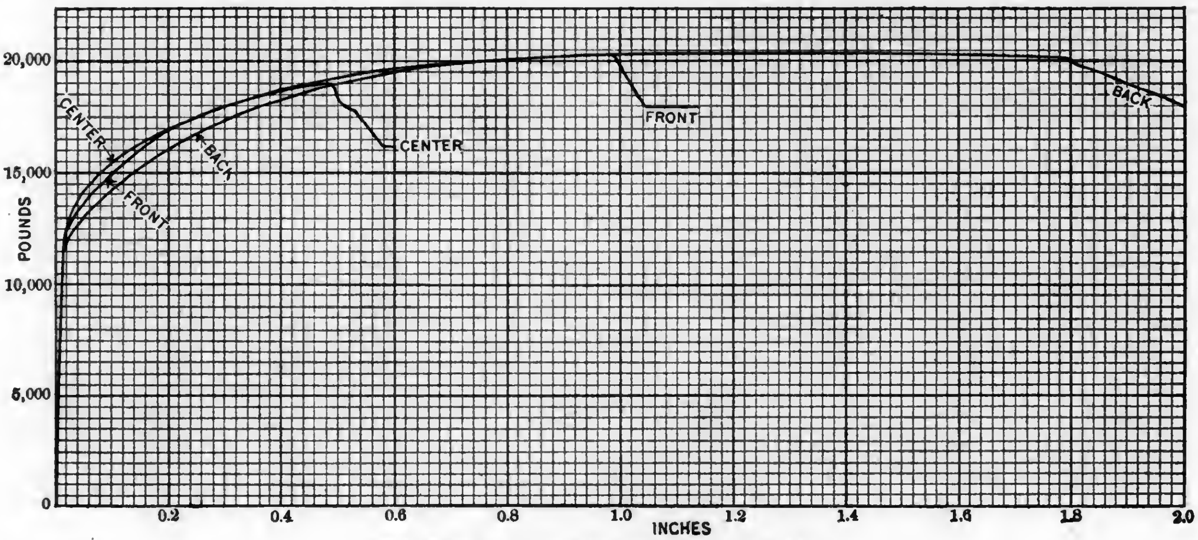
Herewith are presented the record and a copy of the autographic stress-strain diagrams obtained from coupons cut from the front, center and back respectively, of the crown sheet of a Belpaire locomotive boiler. The locomotive was first put into service in July, 1894. In December, 1897, it was slightly scorched or overheated, due in all probability, to low water. It became badly pocketed between the heads of the crown sheet stays, but there was no explosion or giving way of the sheet. The plate was purchased on specifications calling for 55,000 to 65,000 lbs. per sq. in. of tensile strength and 28 per cent. elongation in 8 in.



The Effect of Overheating a Crown Sheet.

	Front.	Center.	Back.
Size, inches	1 × 0.335	1 × 0.337	1 × 0.324
Area before testing, sq. inches	0.335	0.337	0.324
Area after testing, sq. inches	0.240	0.271	0.144
Per cent. reduction in area	28.4	19.6	55.55
Strength, lbs. per sq. in.,			
at elastic limit (= Y P.)	38,060	37,090	37,040
at maximum	60,300	56,380	63,270
at final	53,730	48,960	52,470
Elongation in 8 inches	1.09	0.53	1.97
Per cent. of elongation	13⅝	6⅝	24⅝

The tests and autographic diagrams were made on an Olsen 100,000 lb. automatic and autographic screw machine. The report tells the story in figures, and the diagrams illustrate them graphically. It is to be noted that the 28 per cent. elongation (when new), in a test section 8 in. long is reduced to 24⅝ per cent. at the back test section, to 6⅝ per cent. at the center and to 13⅝ per cent. at the front test section, after the use that it received; that the reduction in area is reduced from 55.55 per cent. at the back to 19.6 per cent. at the center, and to 28.4 per cent. at the front test section; and that the maximum strength is reduced from 63,270 lbs. per sq. in. at the back to 56,380 lbs. per sq. in. at the center. The center coupon showed the highest modulus of elasticity. It gave a rounded diagram, whereas the back coupon gave a sharp corner at the yield point.

The center coupon, after fracture, shows a ruptured or checked surface, on the side of the plate which was next to the water, in places originally about four inches apart and midway between the crown stay rivets. It is quite uniformly but less deeply checked on the fire side. The front coupon is checked only on the fire side, and only near the place of fracture which is at a line of rivets.

While the sheet did not give way and cause a boiler explosion with the attendant loss of life and property, the tests show that the ductility of the sheet had been practically destroyed, and confirm the judgment of the person who ordered it to be replaced.—Stevens Indicator.

CONSOLIDATION LOCOMOTIVES.

RIO GRANDE WESTERN RAILWAY. RICHMOND LOCOMOTIVE WORKS, *Builders*.

Weights: Total of engine ....185,000 lbs.; on drivers ....168,400.
Wheel base: Driving, 16 ft. 8 in.; total of engine and tender, 52 ft. 11 in.
Cylinders: 22 x 28 in. Wheels: Driving, ... 50 and 56 in.; truck...........30 in.
Boiler: Radial stay, extended wagon top; diameter ....71 in.; boiler pressure......... 185 lbs.
Firebox: Length .....122 in.; width.... .. ...41 1/16.; depth, front.... ....77¼ in.; depth, back............71 in.
Grate area ....347 sq. ft. Tubes: 318, 2¼ in.; 14 ft. 3 in. long.
Heating surface: Tubes ....2,667 sq. ft.: firebox...........206 sq. ft.; total.... 2,873 sq. ft.
Tender: Eight-wheel; tank capacity, 5,000 gals.; coal capacity...........10 tons.

HEAVY CONSOLIDATION LOCOMOTIVES.

Rio Grande Western Railway.

The Rio Grande Western Railway has just received eight heavy consolidation locomotives from the Richmond Locomotive Works, one of which is illustrated in the accompanying engraving. The engines are identical in all details, except driving wheels, four of them have 50-inch and the other four 56-inch drivers. The principal dimensions are given in the accompanying table.

General Dimensions.

Gauge	4 ft. 8½ in.
Fuel	Coal
Weight on drivers	168,400 lbs.
Weight in working order	185,000 lbs.
Wheel base, driving	16 ft. 8 in.
Wheel base, total engine and tender	52 ft. 11 in.
Total length of engine and tender	63 ft. 2¼ in.

Cylinders.

Diameter	22 in.
Piston stroke	28 in.
Piston packing	Cast iron
Piston rod, diameter	4 in.; material, iron
Steam ports	1⅝ in. by 21 in.
Exhaust ports	3¼ in. by 21 in.
Bridge, width	1½ in.

Slide Valves.

Style	Richardson balanced
Greatest travel	6 in.
Lap, outside	1 in.
Lap, inside	0 in.
Lead in full gear	1/32 in.

Wheels.

Driving, number	8
Driving, diameter	56 in.
Driving centers, material	Cast steel
Driving box, material	Cast steel
Driving axle journal	9 in. by 12 in.
Crank pin, main	Steel, 7 in. by 6½ in.; 7¼ in. by 5⅞ in.
Crank pin slide rods	Steel, 5¾ in. by 4½ in.; 5¾ in. by 4¾ in.; 6¼ in. by 5⅜ in.
Engine truck, style	Center bearing, swing motion
Engine truck wheels	Number, 2; diameter, 30 in.
Engine truck wheel centers	McKee Fuller C-iron
Engine truck axle	Steel
Engine truck journals	6½ in. by 10 in.

Boiler.

Type	Radial stay, extended wagon top
Working pressure	185 lbs.
Outside diameter, first course	74 in.
Thickness of plates in barrel	¾ in. and 13/16 in.
Thickness of plates, roof and sides	⅝ in.
Firebox, length	122 in.
Firebox, width	41 1/16 in.
Firebox, depth	Front, 77¼ in.; back, 71 in.
Firebox material	Steel
Firebox plates	Sides, 11/32 in.; back, 11/32 in.; crown, 11/32 in.; tube, ½ in.
Firebox water space	Front, 4½ in.; side, 4 in.; back, 4 in.
Firebox crown stays	1⅛ in.
Firebox staybolts	15/16 in. and 1 in.
Tubes, material	Iron
Tubes, length	14 ft. 2⅞ in.
Tubes, number	318
Tubes, diameter	2¼ in.
Tubes, thickness	No. 12 B. W. G.
Heating surface, tubes	2,667 sq. ft.
Heating surface, firebox	206 sq. ft.
Heating surface, total	2,873 sq. ft.
Grate, style	Rocking, finger
Grate area	347 sq. ft.
Exhaust pipe, style	Single
Exhaust pipe nozzle	5½ in.
Smokestack, smallest inside diameter	15 in.
Smokestack, top above rail	14 ft. 8½ in.

Tender.

Weight, empty	43,200 lbs.
Frame	Steel
Wheels, number	8
Wheels, diameter	33 in.
Journals	5 in. by 9 in.
Whele base	17 ft. 11 in.
Tank capacity, water	5,000 gals.
Tank capacity, coal	10 tons

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1895	36,000	80,000	116,000	31.04	68.96
1898	38,500	{ 100,000	138,500	27.80	72.20
		{ 110,000	148,500	25.93	74.07
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1900†	32,500	88,000	120,500	27.00	73.0

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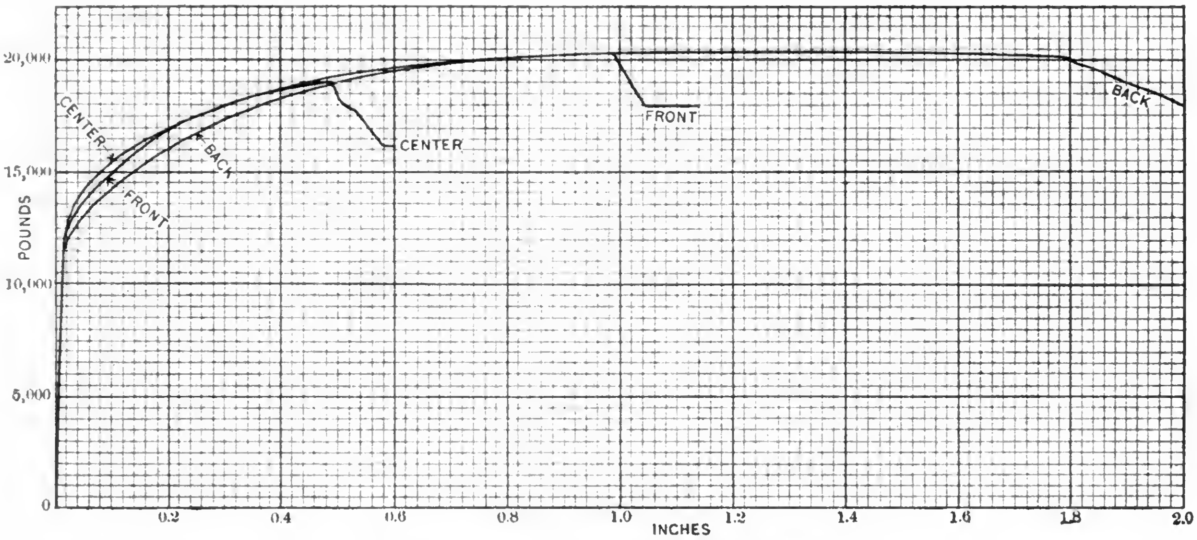

The Effect of Overheating a Crown Sheet.

65,000 lbs. per sq. in. of tensile strength and 28 per cent. elongation in 8 in.

	Front.	Center.	Back.
Size, inches	1 × 0.335	1 × 0.337	1 × 0.321
Area before testing, sq. inches..	0.335	0.337	0.321
Area after testing, sq. inches....	0.240	0.271	0.141
Per cent. reduction in area.......	28.4	19.6	55.55
Strength, lbs. per sq. in.,			
at elastic limit (= Y P.)	38,060	37,090	37,040
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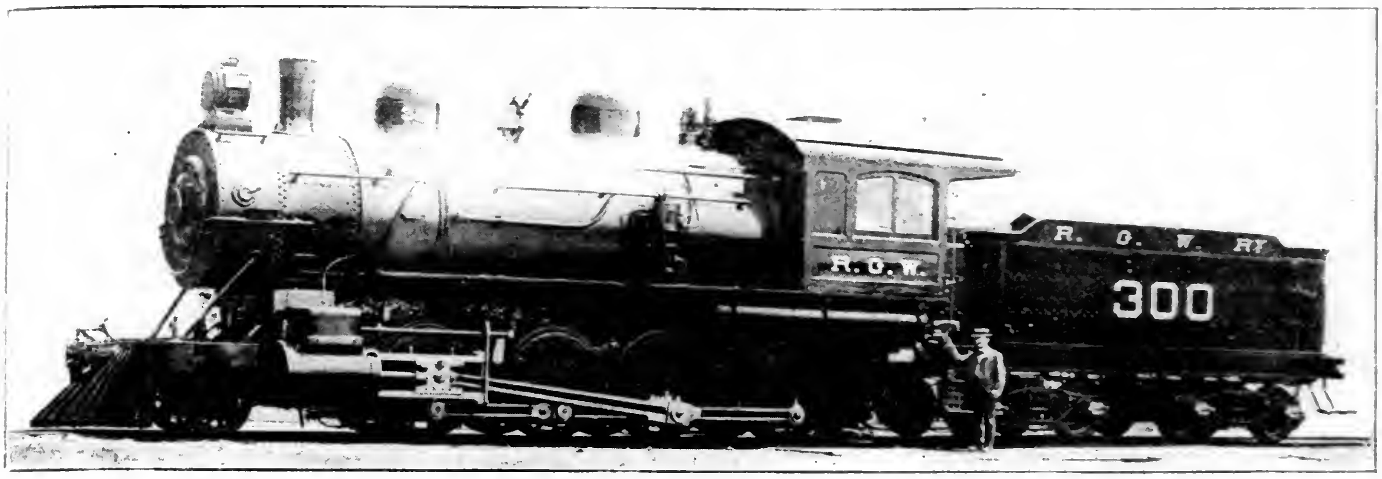

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Cylinders: 22 x 28 in. Wheels: Driving, ... 50 and 56 in.; truck ....30 in.
Boiler: Radial stay, extended wagon top; diameter ......74 in.; boiler pressure........ 185 lbs.
Firebox: Length .....122 in.; width.... .. ...41 1/16; depth, front.... ....77¼ in.; depth, back ....71 in.
Grate area ....347 sq. ft. Tubes: 318, 2¼ in; 14 ft. 3 in. long.
Heating surface: Tubes ....2,667 sq. ft.; firebox...........206 sq. ft.; total.... 2,873 sq. ft.
Tender: Eight-wheel; tank capacity, 5,000 gals.; coal capacity...........10 tons.

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Piston stroke	28 in.
Piston packing	Cast iron
Piston rod, diameter	4 in.; material, iron
Steam ports	1⅝ in. by 21 in.
Exhaust ports	3¼ in. by 21 in.
Bridge, width	1½ in.

Slide Valves.

Style	Richardson balanced
Greatest travel	6 in.
Lap, outside	1 in.
Lap, inside	0 in.
Lead in full gear	1/32 in.

Wheels.

Driving, number	8
Driving, diameter	56 in.
Driving centers, material	Cast steel
Driving box, material	Cast steel
Driving axle journal	9 in. by 12 in.
Crank pin, main	Steel, 7 in. by 6½ in.; 7¼ in. by 5⅞ in.
Crank pin slide rods	Steel, 5¾ in. by 1½ in.; 5¾ in. by 4¾ in.; 6¼ in. by 5⅜ in.
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Engine truck wheels	Number, 2; diameter, 30 in.
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Engine truck axle	Steel
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Working pressure	185 lbs.
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Thickness of plates in barrel	¾ in. and 13/16 in.
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Heating surface, total	2,873 sq. ft.
Grate, style	Rocking, finger
Grate area	347 sq. ft.
Exhaust pipe, style	Single
Exhaust pipe nozzle	5½ in.
Smokestack, smallest inside diameter	15 in.
Smokestack, top above rail	14 ft. 8½ in.

Tender.

Weight, empty	43,200 lbs.
Frame	Steel
Wheels, number	8
Wheels, diameter	33 in.
Journals	5 in. by 9 in.
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(Established 1832)

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PUBLISHED MONTHLY

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R. M. VAN ARSDALE,

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Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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M. C. B. 5½ BY 10 JOURNAL BOX.

New journal boxes for 5½ by 10 inches M. C. B. axles are breaking and it has been found necessary on several roads to make a change in the patterns in order to prevent the bearings from striking the inner wall of the dust guard space. It may be too late to direct attention to the defect in the proposed new standard box with a view of influencing the letter ballot on the adoption of the standard, but the criticism may lead to a reconsideration of the design if it is approved in its present form by the letter ballot.

In another part of this issue Mr. F. M. Whyte, mechanical engineer of the New York Central, reviews the subject thoughtfully and suggests a simple remedy which it has already been found necessary to apply to the journal boxes of this size on that road. It appears that the clearances at the back end of the box, between the bearing and the box, are not enough to provide for the natural roughness of unfinished castings. One-sixteenth inch is not sufficient and the bearing may strike the end of the box before the endwise motion is arrested by the lugs. Clearances which were sufficient for boxes for 3¾ by 7-inch journals are evidently too small for the largest sizes. The stresses are greater with the heavier loads on the large journals and furthermore the opening at the back end of the small box was large enough to let the bearing pass through. The simple remedy of enlarging the opening for the large box will solve the difficulty.

A change in the journal is not to be thought of and the dust guard space and thickness of the rear walls must be maintained. Mr. Whyte's suggestion is to cut out that part of the inner wall at the back where it can be struck by the present bearing. It will not materially affect the strength of the box and there seems to be no objection to the change. The same change appears to be necessary in the 4¼ by 8 and the 5 by 9 boxes. In other words, it must be done in the three largest M. C. B. standard journal boxes. It is easy to understand how the oversight occurred. The cutting away of the back wall has not been made to correspond with the enlargement of the bearings when the larger boxes were designed, and the trouble has been developed by the increase in the stresses which have accompanied the increased loads placed upon the larger journals. The enlargement of the hole has been made by increasing the radius of the top of the opening, but Mr. Whyte shows that the opening should not be cut to a radius but to a shape more nearly conforming to the shape of the bearing.

This will, of course, be remedied by those who are using the journal boxes, but it should have the prompt attention of the association.

Of the four scholarships at Stevens Institute of Technology, endowed by the Master Mechanics' Association, one is vacant, and candidates who have obtained the necessary certificate from Mr. Joseph W. Taylor, Secretary of the Association, will be examined at the Institute, September 16, 17, 18, 19 and 20. There is no doubt of the appreciation of this opportunity on the part of sons of employees or sons of deceased employees of the mechanical departments of our railroads, but it seems strange that there is not a waiting list of those who desire this educational opportunity. The possibilities so generously offered by the Association may not be sufficiently well known and understood among the young men who are eligible, and for this reason we mention the vacancy prominently and suggest that notices be posted upon shop bulletin boards in order to bring the scholarships before the young men who are eligible.

The argument in favor of cars of large capacities by Mr. Loree, which is presented in condensed form in this issue, records the experience of the Pennsylvania Railroad, one of the pioneers in the use of large steel cars. We find it interesting as a record and also because it suggests a study of car design with reference to maximum capacity and minimum dead weight. It may be surprising to many readers to note the comparison in this respect between the large steel cars referred to by Mr. Loree and the two composite cars designed and built by the Norfolk & Western, the weight and paying load ratios of which are remarkably high. This shows what can be done in composite construction with a frame of steel and box and floors of wood. The 100,000-lb. car listed by Mr. Loree appears to be a specially light one and not the pressed steel car which was exhibited at Saratoga. That car, as we remember it, was stenciled 39,800 lbs., which is slightly heavier than the Norfolk & Western hopper car. We are not haggling about small differences in weights, but are endeavoring to point out the possibilities of satisfactorily combining wood and metal for those who desire composite construction.

20-FOOT BOILER TUBES FOR LOCOMOTIVES.

For several years there has been a tendency toward lengthening locomotive boiler tubes and it seems likely to receive considerable impetus through the influence of wider fireboxes for bituminous coal. The tendency is not only to use longer tubes but to increase the ratio of length to diameter, and one motive power officer writes that he has changed the tubes in a mogul engine from 2 in. to 1¾ in. without changing the length, which was 12 ft. 6 in., and has "done wonders with them." He is also using 2¼ in. tubes, 16 ft. long and has no fear of them.

Sixteen feet is common enough now to cause no comment when this dimension appears in a new engine. Mr. S. M. Vauclain advocates 2 in. tubes 20 ft. long, and at the present time a length of 19 ft. has been adopted in a new design for fast passenger service, the diameter in this case being 2¼ in. We think that there are enough straws to indicate which way this wind is blowing. The wide firebox has raised the question of the length of tubes because of its effect upon wheel arrangements. The desire to use long tubes is increased by the necessity of getting large wheels in front of the mud ring.

The relation between the length and diameter is most important, and it is to this that special attention should be directed. The length should not be increased without consideration of this ratio and there are good reasons for believing that an increase in the prevailing ratio is desirable.

In European (Continental) practice the ratio has been 60 for express engines, it has been about 75 in English practice, and from 70 to 80 in American, although Mr. G. R. Henderson has suggested the limits of 70 and 90.

The Pennsylvania Class E1 locomotive was designed with a view of using a ratio of 90, although 86 was finally employed. This shows the tendency toward increasing the ratio and a new design, for which drawings are now completed, will use 19 ft. tubes with a ratio of 100. In Russia 2-in. tubes are in use with a ratio of 108, the length being 18 ft. 1 in., and if Mr. Vauclain should put his idea into practice we shall have a ratio of 120 with 2-in. tubes 20 ft. long.

The famous experiments of M. Henri, chief engineer of the Paris, Lyons & Mediterranean (American Engineer, August, 1890, page 337), and the opinion based upon them has unquestionably influence locomotive practice in confining tube lengths in general practice between 12½ and 14 ft. These tests showed a gain of 7 per cent. in evaporation by an increase from 13 to 16 ft. in length without changing the diameter and tubes 23 ft. long gave 30 per cent. more evaporation than those of 10 ft. The 23 ft. tubes, however, increased the draft resistance. These tests, however, used drafts of 1 to 2.95 in., and drafts of 14 or 16 in., such as occur in American practice might change the conclusions entirely. M. Henri used 78 lbs. of coal per square foot per hour as a maximum rate of combustion. When 250 or 300 lbs. are burned per hour the velocity of the gases in the tubes is vastly greater and therefore these experiments now seem to point toward the desirability of much longer tubes in this country, at least that is the view taken by several well-known men.

Increased friction and reduced draft effect will undoubtedly result from increased lengths of tubes, but we believe that there is much more to be gained in the greater heat absorption than will be lost in these ways. Two different tubes with the same ratio of length to diameter will give the same efficiency for the same velocity of the gases and the long tube may be made larger if necessary. Even if it causes a slight sacrifice in amount of heating surface it is possible that the greater length will be more advantageous than slightly more heating surface in shorter tubes. To determine this positively a very difficult test must be made.

The influence of velocity of the gases has been referred to before in these columns* in connection with Wohler's mathematical analysis of Henri's experiments. The velocity of the gas current affects the action between the gas and the heating surface as does the temperature. The period of contact of the molecules varies inversely as the velocity of the current. Wohler has worked out a table (Bulletin of the International Railway Congress, June, 1899, page 820) to show his idea of the proper ratio of length to diameter required to obtain different degrees of efficiency when the velocity of the gases varies from 5 to 20 ft. per second. These figures call for a ratio of 100 when ordinary efficiency is expected and of 130 as a maximum when the velocity is 20 ft. per second. It is our opinion that in recent practice the velocities greatly exceed 20 ft. per second. The higher the velocity the longer the tubes should be, and for locomotives with high rates of combustion there is good reason to believe that the tubes cannot be too long within the limits imposed by restrictions of weight and space.

M. Henri proved that with light drafts 23-ft. tubes gave an advantage of 12 per cent. over 13-ft. tubes in water evaporation per pound of coal. We may yet come to the 23-ft. tubes, but before this point is reached the Serve tube should come up for consideration. For a given diameter Serve tubes have a heat absorbing surface 75 per cent. greater than that of ordinary tubes, but they are expensive.

There seems to be but one anxiety in the use of long tubes, that concerning the expansion and contraction and its effect upon leakage at the tube sheets. This fear may prove to be without foundation, but if not there is a simple remedy in cambering the tubes by giving them a slight bend before being placed in the boiler. Cambering has been practiced for five years on the Caledonian Railway of Scotland, and we are informed by Mr. J. F. McIntosh, locomotive superintendent of that road, that it was inaugurated for the purpose of relieving the tube sheets from these effects and also to increase the resistance of tubes to bending by their own weight and thereby lessen the injurious effects of vibration in producing leakage at the tube ends. In the opinion of Mr. McIntosh, when the tubes are cambered they are more flexible longitudinally and therefore yield more freely to the expansion and contraction and reduce the stresses at the tube sheets. The tubes are generally cambered by the manufacturers, but this has been satisfactorily done in the shops of the Caledonian in a screw press.

*Article by Mr. Wm. Forsyth, October, 1899, page 311.

NOTES.

RAILROAD MILEAGE IN THE UNITED STATES.

On June 30, 1899, the total single-track railway mileage in the United States was 189,294.66 miles, an increase during the year of 2,898.34 miles being shown. This increase, according to the Interstate Commerce Commission, is greater than for any other year since 1893. The States and Territories which show an increase in mileage in excess of 100 miles are Alabama, Arkansas, Georgia, Louisiana, Michigan, Minnesota, Pennsylvania, Texas, Arizona, New Mexico and Oklahoma, Practically all of the railway mileage of the country is covered by reports made to the Commission, the amount not covered being 1,759.98 miles, or 0.93 per cent. of the total single-track mileage. The aggregate length of railway mileage, including tracks of all kinds, was 252,364.48 miles. The distribution of this aggregate mileage was as follows: Single track, 189,294.66 miles; second track; 11,546.54 miles; third track, 1,047.37 miles; fourth track, 790.27 miles; yard track and sidings, 49,685.64 miles.

The increased capacity of modern locomotives on our best roads is strikingly illustrated by a reference in the recent annual report of the Chicago & Northwestern stating that during the year 82 locomotives have been built to replace the same number of old ones. The new ones have an aggregate tractive power equivalent to that of 203 engines of the old class, the gain being 147½ per cent.

PERSONALS.

Mr. William Hunter, Acting Chief Engineer of the Philadelphia & Reading, has been appointed Chief Engineer.

Mr. W. G. Tait has been appointed Purchasing Agent of the Wisconsin & Michigan, with office at Chicago.

It is officially announced that Mr. J. S. Turner is appointed Master Mechanic of the Fitchburg Division of the Boston & Maine, with office at Charlestown, Mass.

Mr. Charles Hansel has been appointed General Manager of the General Power Company, manufacturers of the Secor internal combustion engine, with offices at 100 William Street, New York.

The University of Michigan has conferred upon Mr. A. A. Robinson, President of the Mexican Central, the degree of Doctor of Laws, in consideration of his "eminence as an engineer and railway administrator."

Mr. W. F. Dixon informs us that he has resigned as Chief Engineer of the Sormovo Works at Nijni-Novgorod, and become connected with the Singer Manufacturing Company. His new address is Podolsk, Moscow Government, Russia.

Mr. James Dun, Chief Engineer of the Atchison, Topeka & Santa Fe, has been appointed Chief Engineer of the entire Santa Fe system. Mr. W. B. Storey will succeed Mr. Dun as Chief Engineer of the Atchison, Topeka & Santa Fe Railway.

Robert S. Hughes, President of the Rogers Locomotive Company, died recently at his home, in Paterson, N. J. Mr. Hughes was 73 years old and his life-work has been with the Rogers Locomotive Company and the firms which it succeeded.

Mr. Richard D. Gallagher, Jr., has been appointed Mechanical Engineer of the Standard Coupler Company. Mr. Gallagher has for some time been connected with the car department of the Grand Trunk Railway at Montreal, and was formerly with Pullman's Palace Car Co. at Pullman.

Mr. J. R. Groves, recently Superintendent of Machinery of the St. Louis & San Francisco, has been appointed to a like position with the Colorado Midland, with headquarters at Colorado City, to succeed Mr. A. L. Humphrey, who resigned in June to become Superintendent of Motive Power of the Colorado & Southern.

Mr. Frederic A. Miller, who is to succeed Mr. G. F. Heafford as General Passenger Agent of the Chicago, Milwaukee & St. Paul at Chicago, entered the General Passenger Department of this company in 1883 as a clerk. Two years later he was appointed General Agent, and in 1887 Assistant General Passenger Agent, which position he now holds.

Mr. F. E. Blaser, of the Chicago, St. Paul, Minneapolis & Omaha, has been appointed Purchasing Agent of the Ohio River. He entered the services of the Chicago, St. Paul, Minneapolis & Omaha at the age of 11 years, as a spike peddler and water carrier, and has worked through various responsible position. His entire railroad career has been spent with this company.

Collis P. Huntington, President of the Southern Pacific, and one of the most prominent financial magnates of the present time, died suddenly August 14, at Pine Knot Camp, his summer home, in the Adirondacks. Mr. Huntington was 79 years old, and a large part of his history is bound up with the construction of the Central Pacific. He went to the Pacific coast in 1844 during the days of the gold rush and entered into the trading business on a very small scale, with the money he had previously saved from peddling and trading. His capital grew until, with Mark Hopkins, Leland Stanford and Charles and E. B. Crocker, he organized the Central Pacific Railroad Company, the organization and growth of which form a very interesting and instructive chapter in the history of railroad growth. The organization of the Southern Pacific followed, in which 26 corporations were absorbed. Among other great properties which owe their existence to Mr. Huntington's foresight are the Pacific Mail Steamship Company and the Newport News Dry Dock and Shipbuilding Company. He was also interested in many varied companies as a director.

ACETYLENE FOR RAILROAD LIGHTING.

In a paper by Mr. A. Lipschultz, of the Great Northern Railway, published in the June number of the "Journal of the Association of Engineering Societies," we find a carefully considered discussion of the application of acetylene to railroad conditions. Mr. Lipschultz describes what appears to be an excellent field for acetylene as follows:

The Great Northern Railway has at Hamline a freight transfer house, which consists of a warehouse about 800 ft. long, having loading platforms at each side for the entire length of the building. The offices are located at one end of the structure. There are altogether about 100 burners, of which 26 are in the office, while the rest of them are grouped in three rows; one row being in the center of the freight house, and the other two rows on the platforms. The generator is installed in a small building about 20 ft. distant, which also serves as a dining room for the men. The office lights burn all night, while the lights in the freight house and platforms are needed for about four hours daily in the winter. The generator is a 100-lb. carbide machine, and is charged every other day. The cost per lamp-hour (22 c. p.) varies from 0.55 cent to 0.65 cent, according to the amount of gas used. This includes attendance, depreciation and renewals. The light furnished by the acetylene plant has reduced the cost per ton of freight handled, and no other system of lighting could be installed at that place which would rival it in economy. We have now a number of passenger stations and freight depots equipped with acetylene plants in operation, and several others under construction, ranging from 20 to 60 lights each, and in no case has an acetylene plant been decided upon except where, by its smaller operating cost, its independence of rented sources of light and its fine illuminating qualities, it has shown itself to be superior to other systems of lighting.

The author of the paper then turns to train lighting and soon disposes of all methods of using gas generators on the trains themselves. With small generators the heat of the chemical action renders the gas impure and this leads to the stopping up of pipes and burners. The charging of generators is always objectionable on account of the odor, and the amount of care required of the train men is considered a serious disadvantage. Only in the system in which the gas is made in a central plant and stored under pressure on the cars is the train crew relieved from attendance and "this in itself is a grave inconvenience." The railroads have been educated through the present compressed gas system to demand that the lighting of trains shall require only the minimum amount of attention from the train men, and systems which require careful regulation of apparatus will not be acceptable.

Mr. Lipschultz discusses at some length the effect of pressure upon the safety of acetylene. In Europe the Pintsch people use mixtures of acetylene and Pintsch oil gas to enrich the gas and there was no danger of explosion when a tank of this mixture at 150 lbs. per sq. in. was heated to the dissociating tem-

perature of pure acetylene. According to the author of this paper, acetylene when stored under a pressure of not more than 30 lbs. cannot produce a dangerous explosion when heated to the dissociating point, and the system of lighting suburban trains having short runs with acetylene carried in tanks at 30 lbs. pressure has been in successful operation for several years. This low pressure, however, is inadequate for long-distance trains and, says the author, in order to use acetylene stored at the same pressure as in the system of the Pintsch Gas Company, this latter company made tests with acetylene stored under 150 lbs. pressure; first in a tank having riveted seams, and then in its own standard tank which has riveted and soft-soldered seams. When the tank with riveted seams was heated to the dissociating point, or about 1,432 degrees F., an explosion took place which demolished the tank. In the second test with its own tank, having soft-soldered seams, the solder commenced to melt when a temperature of about 380 degrees F. was reached, thereby springing a leak by which the gas escaped, burning out quietly without any injury to the tank. It was therefore concluded that acetylene under 150 lbs. pressure stored in such a tank could be carried safely even in case of an accident by which the car might be overturned and the wreck catch fire. As already mentioned, there are no means of exploding a tank filled with acetylene gas at high pressure except by heating it to or above a temperature of 1,432 degrees F., as neither shock nor concussion will produce an explosion.

The paper points to the possibility of an explosion in the event of a wreck by heating the high-pressure pipes leading from the gas tank to the reducing valves. This pipe might be heated at a point about 4 ft. away from the tank and in such a way that the seams of the tank would not be melted and an explosion occur. To guard against this the system described by Mr. Lipschultz employs piping which will melt at a temperature of 400 degrees F. These pipes are believed to overcome the difficulty entirely and "render an explosion impossible," but it is nevertheless considered necessary to provide a safety valve by which the gas escapes when a derailed car turns on its side.

According to this authority, economy can be had only in the manufacture of acetylene in a central station plant where a gas of high candle-power is produced. The entire plant can be run by one man, even if the plant has a daily capacity of 10,000 ft., which is equivalent to more than 30,000 ft. of Pintsch gas. A tank under a coach can be filled by unskilled labor in from two to three minutes, and, after this operation is performed, only the lighting and turning off of the lamps remain to be done by the train men.

It is rather disappointing to fail to find in the paper any reference to the clogging of burners. The Pintsch people in their long successful experience do not consider it wise to use a richer gas than that which gives from 10 to 12 candles per cu. ft. This was discussed in our issue of October, 1899, page 329, where it was stated that a change from a diameter of orifice of 0.023 in. to 0.029 in. was a great improvement. The lighting of trains is a peculiar service in this respect and a system which is entirely satisfactory for stationary lighting may give serious difficulty on trains for this reason. Richer gas would require smaller orifices, and this is a question which has not been touched upon in this discussion. It is believed to be important.

While acetylene seems to be a very attractive source of light for many purposes, conservatism in accepting it as a safe medium in view of the precautions mentioned by the author of this paper is fully justified, especially for train lighting.

The author of the paper is enthusiastic about acetylene for car lighting, but, as we understand it, his favorable opinion is based upon expectations rather than extended experience. The present compressed gas system in general use is so satisfactory that anything entering the field against it must be ideal in every respect and particularly with regard to reliability and easy maintenance.

BRAKE BEAM PRESSURES.

Unexpected Stresses Developed by Tests.

That brake beams are subjected in ordinary service to excessive stresses and even beyond the requirements of the Master Car Builders' Association has been demonstrated in a series of interesting tests by the University of Illinois, made with the assistance of Mr. H. M. Perry, of the Chicago Railway Equipment Company, and Mr. McClurg, Master Mechanic of the Peoria & Eastern Railway, in the yards of that road at Urbana, Ill. The chief object of the tests was to ascertain the effect in brake beam pressure of suddenly starting a car upon which the brakes had been set while at rest. Fig 1 illustrates the action. The shoe S, being below the center of the wheel,

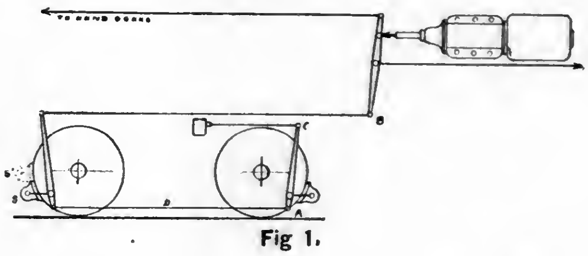


Fig 1.

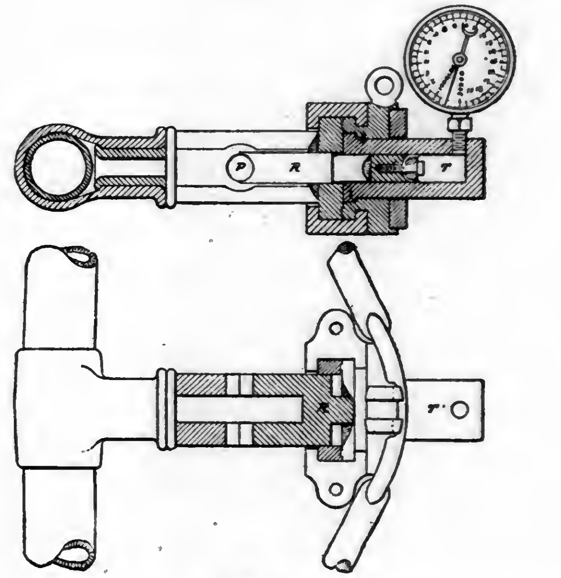


Fig. 2.

will rise to a position represented by the dotted brake head when the car is started toward the right. This will increase its distance from A and increase the tension in the rod D, because there can be no yielding at C.

Brake beams were fitted, as shown in Fig. 2, with a hydraulic gauge to measure the pressure on the brake beam. Pressure was transmitted to the brake beam through a plunger sliding in the strut, R, which communicated the pressure to the oil cylinder T and permitted of measuring it with the gauge. These beams were applied to two cars, one of which was new and had run only long enough to make its journals and brake-shoes smooth, while the other was an old car with slack bearings and brake rigging. The braking power was 64.7 per cent. for the new car and 64.3 per cent. for the old one. After both had been run over a sanded track to insure good contact between the shoes and wheels, the brakes were set firmly by air or by hand when the cars were standing. Then the cars were suddenly started and the rising of the brake-shoes caused the brake beam pressures to increase, as was explained.

In the test of the old car the brake beam pressure, when the brakes were set by hand, ranged from 5,800 to 8,000 lbs. This was increased from 22 to 47 per cent. by the rise of the

shoes. In the case of the new car the brake beam pressures when set by air ranged from 4.200 to 4,750 lbs., and these were increased, on starting the car, from 10.5 to 31 per cent. In another test with this car the brakes were set by hand, giving pressures ranging from 4,200 to 10,450 lbs., and these were increased in starting from 12 to 114 per cent.

These are wide ranges and there are so many opportunities for variation in the conditions as to render an average misleading. The highest pressure, 14,050 lbs., is more than 2½ times the pressure calculated for an emergency application and this should be considered by those who are defending their use of weak and cheap brake beams on the ground that emergency applications are so rare that they can afford to take chances with brake beams which are known to be too weak to withstand them. Here is proof that in ordinary use of cars the brake rigging may be subjected to several times the amount of stress supposed to be produced by emergency applications and the natural inference is that brake beams should be made as strong as possible. This rise of the brake beam will occur also in braking on the road and it is possible that the pressures may be increased in emergency applications in fast trains even beyond the figures found in these tests.

The tests also exposed weaknesses in foundation brake gear, chains, hangers and ratchet keys gave way repeatedly. The conditions were exceptionally severe, but they represent what may and probably often does occur in the rough handling of cars in switching. If other service proves to be still more severe there is good reason for revising foundation brake gear design. The M. C. B. standard for brake beams calls for a deflection of not more than 1/16 in. under a load of 7,500 lbs. at the center, and if it is necessary to use a stronger beam the specifications call for 15,000 lbs. with a deflection of not more than 1/16 in. It would be well to investigate present practice on this basis and bring the rest of the gear up to this standard.

It must be remembered that these tests concerned only outside hung brakes. If the shoes were placed between the wheels the destructive rise of pressures would not occur and these experiments add a strong argument to the many in favor of the inside arrangement. With the present high speeds of freight trains there is no danger of giving too much attention to the brakes, but there seems to be considerable danger of neglecting to bring them up to the requirements imposed by conditions which are changing continually in the direction of greater severity.

RAILROAD EMPLOYEES IN THE UNITED STATES.

The number of persons employed by the railways of the United States as reported to the Interstate Commerce Commission on June 30, 1899, was 928,924, or an average of 495 employees per 100 miles of line. As compared with the number employed on June 30, 1898, there was an increase of 54,366, or 21 per 100 miles of line. From the classification of these employees it appears there were 39,970 enginemen, 41,152 firemen, 28,232 conductors and 69,497 other trainmen. There were 48,686 switchmen, flagmen and watchmen. Upon the basis of special returns made to the secretary of the commission, it appears that the number of switchmen, flagmen and watchmen included in this aggregate could fairly be assigned in the proportion of 6, 3 and 2, respectively.

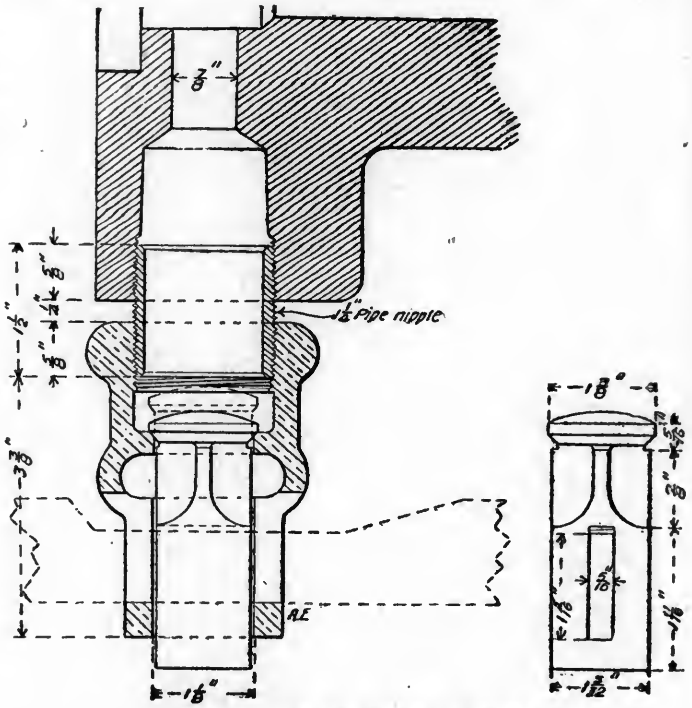
Disregarding 9,334 employees not assigned to the four general divisions of employment, it is found that the services of 34,170 employees were required for general administration, 287,163 for maintenance of way and structures, 180,749 for maintenance of equipment and 417,508 for conducting transportation.

The report contains a statement of the average daily compensation of eighteen classes of employees for eight years, beginning with 1892. A summary in the report also gives the total compensation of more than 99 per cent. of railway employees for the fiscal years 1895 to 1899. During the year ending June 30, 1899, $522,967,896 were paid in wages and salaries, an amount $77,459,635 in excess of that paid during 1895. The compensation of the employees of railways for 1899 represents 60 per cent. of their operating expenses and 40 per cent. of their gross earnings.

CYLINDER COCKS FOR LARGE CYLINDERS.

Some railroads in following established standards perhaps too closely, or too long, have lost sight of the fact the cylinder cocks which were efficient some years ago will not quickly drain the water from cylinders of modern locomotives, which may be several inches larger in diameter than was used or contemplated when the cock was made a standard. Mr. C. A. Seley, Mechanical Engineer of the Norfolk & Western, has kindly sent us a drawing showing the present practice on that road.

It is not improbable that the low-pressure cylinders of compound locomotives, measuring 35 inches in diameter, are provided with a ½-inch drainage hole and a cock originally designed for a 16 or 17-inch cylinder. This is a point to be looked after, particularly in locomotives with piston valves, as these



Cylinder Cocks for Large Cylinders.
Norfolk & Western Railway.

valves cannot lift to relieve the pressure, and the relief valves may be inefficient or absent altogether. With a good cylinder cock, however, the water may be quickly discharged if caught in time.

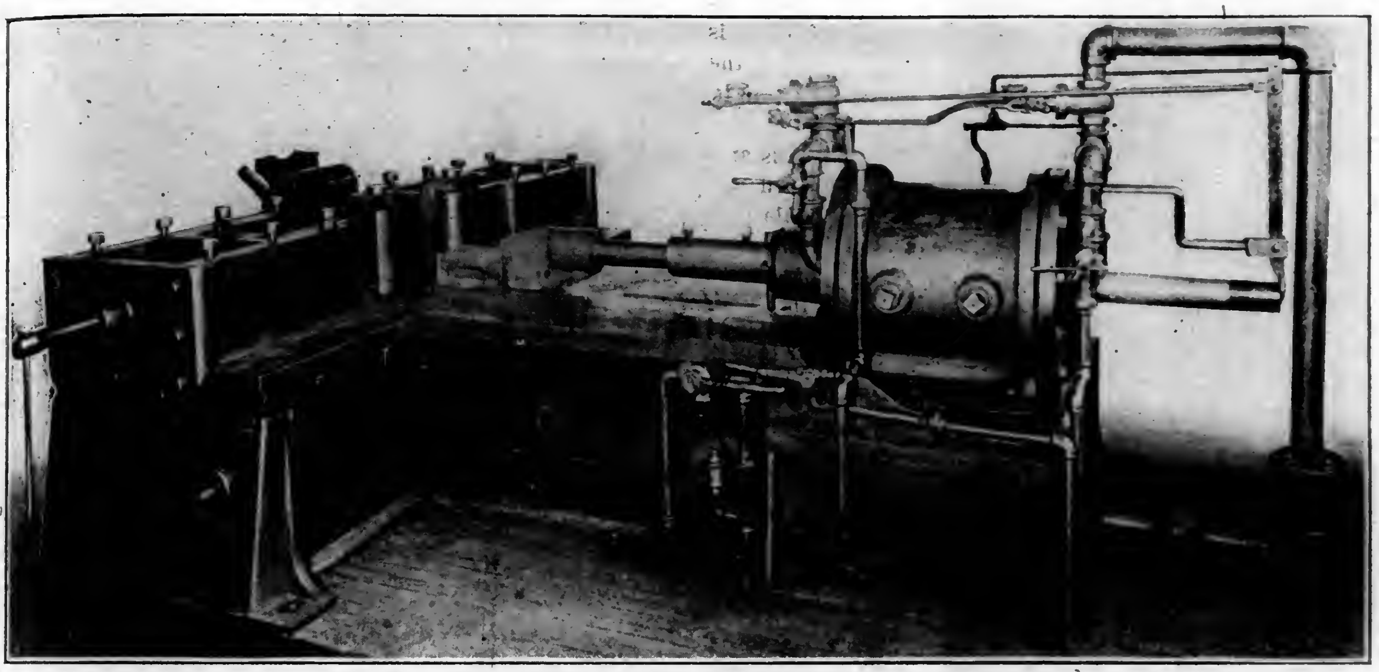
Cylinder cocks are frequently knocked off, and when this is done, with many designs they are only valuable as scrap. This is particularly true of those styles that have a threaded shank to screw into the cylinder. Break off the shank and the cock is useless and thrown into the scrap. A design, not original, but perhaps new to some, has been made standard on the Norfolk & Western Ry., which has a very free delivery and can be used again if knocked off. The idea of mounting the cock on a nipple is not original. This was done some years ago on the Southern Pacific, but the application so arranged as to make use of existing cylinder cock rigging without change is novel.

The drawing shows that the cock has been made rather stocky, particularly around the thread, which is made to rereceive a 1¼-inch pipe nipple. Ordinarily the nipple will break when the cock is hit, and it can be dug out, replaced and the cock used again. The passages are made so as to pass the full area of a ⅞-inch hole which is the size of the hole drilled up into the cylinder, although it could be made larger if desired. These cocks are very inexpensive to make so far as cost of finish is concerned, and they have proved very satisfactory in service.

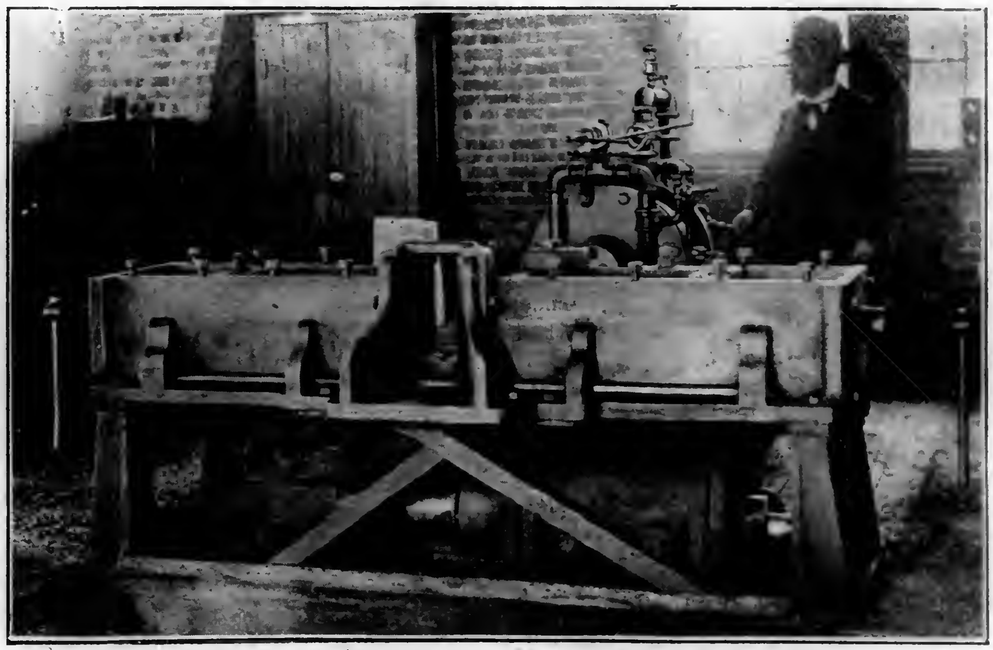
HEAVY PNEUMATIC FORGING MACHINE.

Illinois Central Railroad.

A very powerful pneumatic forging machine is in course of erection at the Burnside shops of the Illinois Central Railroad. It will perform all the functions of a forging machine, riveting machine and a bulldozer, and is not improperly called a "mechanical blacksmith." It is very simple of construction and operation, is limited in speed only by the readiness with which a man can operate an angle cock and performs a remarkably large number of different operations in forging, riveting, bending, welding, pressing and shaping of materials. The most complicated of these operations being accomplish in one heat.



Powerful Pneumatic Forging Machine—Illinois Central Railroad.



Powerful Pneumatic Forging Machine—Illinois Central Railroad.

This machine, which is an exact reproduction of a much smaller machine now in operation at these shops, has cylinders 24 x 31 ins. and will be operated with an air pressure of 125 lbs. From the engravings it will be seen that the frame consists of two heavy castings suitably fastened together to form a T-shaped bed-plate, on the longer arm of which is mounted longitudinally a 24-in. cylinder which furnishes power and motion to the hammer piston. The piston rod passes through both ends of the cylinder and on the driving end is a socket for receiving the stems of the male dies, while the other end projects far enough beyond the end of the cylinder so that when the piston is forced back to the beginning of the stroke, it will strike a lever which opens the exhaust valve, thus causing an automatic control of the exhaust. On opposite ends of the short arms of the frame are arranged adjustable die blocks which have a dovetailed and grooved connection with the bed plate and move at right angles to the hammer piston. These die-blocks are rectangular in form and are provided with rollers at the two inner corners, which come in contact with the metal as it is forced into the dies. The adjustment of these blocks is made independently toward and away from each other by means of screws working through plates bolted to the ends of the frame and engaging removable plates in the die-blocks at the other end. It is desirable in some classes of work, such as welding and forging, to have one of these die-blocks capable of use as a pneumatic hammer, which greatly increases the amount and character of the work performed. The construction of the dies is also made very simple by this arrangement, and they can be put into place and ready for operation in a very short time, as the dies for nearly all of the complicated operations simply lift in and out of the forms. To give power to the movable die an auxiliary cylinder 24 ins. in diameter is placed beneath the short arms of the frame of the

machine. In this cylinder is a piston, the rod of which is connected to the die-block on the farther end of the bed-plate by means of a lever. The pin of this connecting lever can be dropped into one of two holes in the die-block to give it suitable length of vibration. When air is let into the cylinder alternately on opposite sides of the piston the die-blocks will act as a hammer for delivering lateral blows.

The hammer piston and the die-holding piston can be operated either separately or in conjunction with each other, while the force of a blow or static pressure in either case can be controlled at will. These adjustments are made by the opening or closing of the cut-out cocks in the line of piping in front of which the operator stands. To strike a blow with the hammer, the lever valve just over the right-hand end of the cylinder is opened. This admits air from a reservoir suitably located under the frame of the machine, to the right end of the cylinder in such measure as the valve is opened; when the blow has been struck the valve is closed and the pressure remains on. By having previously set the cut-out cocks properly, in the smaller lines of piping the air in the cylinder will pass around to the other side of the piston and force it back to the power end of the cylinder. When the piston has arrived at the end of its return stroke the extension of the right-hand end of the piston rod will strike the trip lever, which in turn opens an exhaust exit to the air. The operation of the die-holding piston is made independently by the turning of an angle cock in the large and small lines of piping leading from the reservoir to the die-operating cylinder.

For such operations as safety straps for body truss rods and needle beam washers the die-blocks are screwed toward the center of the machine and form the sides of the female die, while the proper shaped male die on the piston arm bends the heated bar around loosely journaled rollers in the front corners of the die-blocks and forces it between the dies. In forming transom tie-bars, carry irons and work with four bends the operation is the same with the exception that the rollers are replaced by filling blocks, which give square shoulders to the die forms. In such work as center brake-lever carriers and draw-bar yokes a two-part die is inserted firmly between the two die blocks, which act in this case as a vise, and the bar operated on in three different positions. In forging swing-hanger bolts the side die is used as a pneumatic hammer which forms the bosses and heads by upsetting the metal from the bar, while the main hammer is held up to the work during the operation of the die-blocks. For riveting and welding the operations are simple and can be performed by the use of either hammer.

At a recent exhibition of this machine at the Burnside shops our representative noted the time required to change the dies for five different operations, which ranged from one to three minutes, the machine in all cases being ready for operation before the metal in the furnace could be brought to the proper heat.

We are indebted to Mr. M. Kennedy, foreman of the Illinois Central blacksmith shops, for the accompanying illustrations. Mr. M. Kennedy, the designer and perfector of this machine, has spent much time in making it the very complete and efficient blacksmithing tool that it is, and has had the hearty support of Mr. William Renshaw, superintendent of machinery of the Illinois Central, in the development and construction.

The absurdity of making thirteen steam joints in a blower pipe between the steam dome and the smokebox is immediately apparent when attention is directed to it. On an engine on one of the leading roads this number was counted and probably there were more which were concealed. This implies a large number and variety of fittings and suggests the importance of a standard of simple construction. There is an increasing tendency toward simplicity in piping and it is especially important in air brake apparatus where every angle and bend has its effect upon the rapidity of action, but much more remains to be done in this direction.

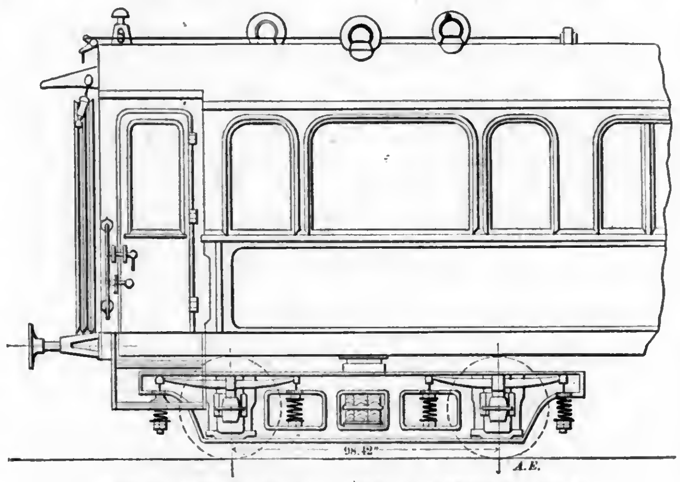
FOUR-WHEEL TRUCKS FOR HEAVY PASSENGER CARS.

A Suggestion from Swiss Practice.

If the present four-wheel passenger truck can be improved to give it the smooth riding qualities of the six-wheel truck it seems reasonable to believe that it will be used more extensively for heavy passenger cars and other heavy equipment, such as parlor cars, baggage, mail and express cars, smoking and sleeping cars. The shorter wheel base of the four-wheel trucks must be less destructive to the track and this type is unquestionably lighter and less expensive to maintain. The question is how to improve the riding qualities of the four-wheel truck.

Our attention has been directed to the arrangement of springs under passenger cars recently built for the St. Gotthard Railway, of Switzerland, and Mr. A. Christianson, of the motive power department of the Central Railroad of New Jersey, has kindly furnished a translation of a description of them, which recently appeared in the "Organ fur die Fortschritte des Eisenbahnwesens."

These cars are heavy and nearly correspond with the dimensions of American practice. They are 60 ft. long over vestibules; 9 ft. 6 in. wide, outside; 44 ft. 3 in. between the center of the



Four-Wheel Truck for Heavy Passenger Cars. St. Gotthard Railway.

trucks; the wheel base of the truck is 8 ft. 2½ in., and the car, when empty, weighs 72,730 lbs.

The engraving shows the arrangement of the springs from which it is seen that the equalizer, so prominent a member in American practice, has been omitted entirely, and the shocks are taken directly over the journal boxes by elliptic springs suspended at both ends by coil springs. This arrangement is attractive. It suggests the question whether the use of an equalizer in four-wheel trucks is justified. Does it serve as an equalizer for the load or as a reducer of shocks? Does it not simply transfer the shocks through the equalizer spring to the wheel-beam nearer to the center of the truck? In this way the shocks are apparently reduced, but as the distance from the equalizer spring to the center of the truck is reduced the shock actually remains the same as if taken up by the wheel-beam directly over the journal. The equalizer may even be detrimental because it acts as an inert mass with its weight resting directly on the journal without the cushioning effect of a spring and it therefore must increase the wear of the bearing.

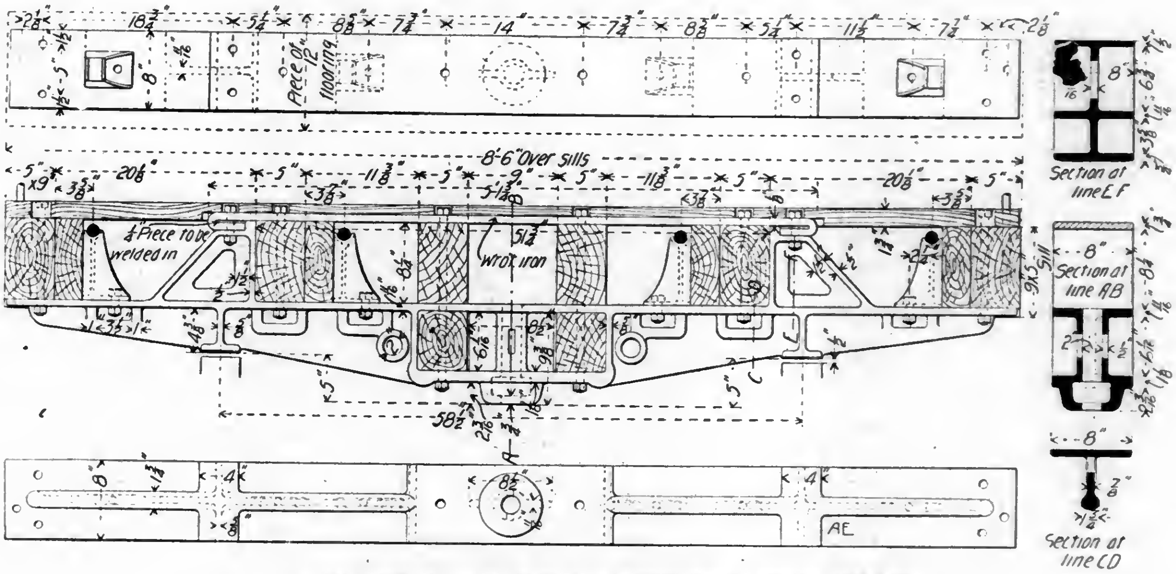
If the equalizer is absent, the wheel-beam must be strengthened in proportion to the increase of leverage due to moving the springs outward to points over the centers of the journals. If this is done and a better form of spring, the half elliptic, is substituted for the usual coil spring in such a way as is outlined in the engraving, the riding qualities of the truck should be equal to if not superior to those of six-wheel trucks.

CAST STEEL BODY BOLSTER.

Chicago, Rock Island & Pacific Railway.

The accompanying engraving illustrates a cast steel body bolster designed and patented by Mr. G. A. Akerlind, Chief Draftsman of the Chicago, Rock Island & Pacific Railway, to take the place of wrought-iron bolsters formerly used on that road. This bolster is very strong and comparatively light, weighing but 416 pounds complete.

The problem was to make provision for the draft-timbers to pass through the center and at the same time use as few parts as possible and give them sufficient strength to keep the car off of its side bearings. It will be seen that the number of parts is reduced to a minimum, there being but six pieces in all, including the four truss rod brackets, which are separate castings bolted to the main casting with ¾-in. bolts, and resting against the inner faces of the filling blocks which are interposed between the outside and intermediate sills and these brackets. This bolster is used for 60,000-lb. box and stock cars of the Rock Island road, also the same design is used on 80,000-lb. coal cars with a little different arrangement of side sills, which are, in the case of the coal cars, much deeper than the center and intermediate sills.



Cast Steel Body Bolster with Removable Tension Member.
Chicago, Rock Island & Pacific Railway.

From the engraving it will be seen that the sills all bear on a substantial main casting which allows a wide arrangement of these sills. Sections through the bolster are given to the right in the engraving, in which section E, F, shows the form of the lower-webbed portion, and the open spaces 3½ by 1¼ in. cored in the web for convenience in getting at the nuts of the bolts which fasten the sills and truss rod brackets; A, B, shows the form of the upper center plate which is integral with the bolster and C, D, which is a section taken through the part forming the upper side bearing. Two 2-in. openings are also provided for the air-brake pipes.

The tension member is an 8 by ¾-in. wrought-iron plate 59¼ in. in length with 3¾ in. bent down at each end in such a manner as to form a square bearing surface with two 1¼ by 8-in. lugs cast on the body of the bolster not less than 51¾ in. apart. The space between the bent down ends of the tension member has a ¼-in. filling piece welded in. This tension member, which is given a driving fit, is fastened by four ¾-in. bolts, two at each end, and it may be removed and the bolster taken down, when necessary, without removing the end sill of the car.

This bolster was originally intended to be of malleable iron, and some trouble was experienced from breakages originating from hidden cracks in the metal. The whole trouble was due to the fact that the castings were not malleable, as was supposed, but ordinary gray iron. Steel has been used exclusively for the past three years and the bolster has during this period of service been satisfactory in every way and they have given no sign of breakage. These bolsters are being applied to all of the new cars of the three classes mentioned. They are made by the American Steel Foundry Company, of St. Louis.

HOT WATER HEATING IN INDUSTRIAL WORKS.

So long as the exhaust steam is used as the agent of heat distribution, it does not appear that there is any practicable way in which the heat of the exhaust flue gases can be applied to the same system. The temperature of the exhaust steam is at least 212 degrees, so that it can absorb heat from the flue gases at only a very slow rate. Moreover, the steam has only a small capacity to absorb heat, unless raised to a very high pressure, which would be prohibitive. Water, on the other hand, may be easily raised to nearly 212 degrees by exhaust steam at the pressure of the air, and the flue gases may be subsequently used to push it materially above this figure if desired. As the flue gases are much hotter than the exhaust steam, though the total heat units which they can give up are only a fraction of those in the steam, it will usually be more convenient, for general heating purposes, to give the circulating water somewhat less than 212 degrees by the exhaust and then to reach or go slightly beyond this figure through the application of flue gases.

While in heat distribution by exhaust steam its minimum temperature is usually 212 degrees, in distribution by hot water the lowest working temperature must be much less than this figure. A limit is soon reached, however, for the reduction in temperature of the circulating water, because of the consequent decrease in the value of radiating surface. Just how low the temperature of the circulating water should be permitted to go depends somewhat on local requirements, but a drop of about 61 degrees from 212 can be permitted in many cases. With this change of temperature, each pound of water gives up 61 heat units, so that 1 cu. ft. of water, weighing 60 lbs. at about 212 degrees, offers an available storage capacity of 3,660 heat units. A cubic foot of steam was found to have a storage capacity in its latent heat of 36.6 units, or only 1 per cent. of that offered by the hot water of equal bulk.—A. D. Adams, in Cassier's Magazine for August.

WHAT IS THE IDEAL FAST PASSENGER ENGINE?

The comparative merits of the American or 8-wheel, the Atlantic, Columbia and Atlantic types for fast passenger service were considered by Mr. S. M. Prince, Jr., Superintendent of Motive Power of the Philadelphia & Reading in the "Railroad Gazette," June 22, 1900, page 412, in an interesting and timely article.

Mr. Prince is no stranger to the Columbia type, having outlined such a wheel arrangement in 1882. He soon after came to the conclusion that "the only true high-speed engine would be one with a wide or Wootten firebox and large driving wheels placed under the firebox, or, in other words, an American type engine raised sufficiently high to accommodate the size of driving wheels."

This idea he worked out in a design of an 8-wheel engine with a wide firebox and 78-in. driving wheels under it, and even with wheels of this size the center of the boiler is but 9 ft. 2⅝ in. above the rails. This engine was rebuilt, using an old boiler, and Mr. Prince says that in building an entirely new engine the wheels could be 84 in. in diameter with the same length of boiler.

He believes this to be the ideal type of high-speed passenger locomotive and when it is necessary to secure higher capacity than may be carried on 8 wheels; he would add 2 driving wheels instead of trailers. The conditions as to right wheel base are practically the same in both cases, and the 10-wheel type has the advantage of using the weight on the rear wheels for traction. Mr. Prince holds that nothing can be said in favor of the Columbia or Atlantic that cannot be said of the 10-wheel type, and he believes that nothing has been accomplished by the Columbia and Atlantic that cannot be more satisfactorily accomplished by the 8-wheel and 10-wheel types. He describes an 8-wheel engine, outlined by him several years ago, with 84-in. driving wheels and the center of the boiler 9 ft. 3 in. above the rails. The height of the boiler in any of these types was determined by the size and location of the cylindrical part with reference to the driving wheels. In recent Atlantic type engines the boilers were as high as this and Mr. Prince raises the question why they were not of the 8-wheel type.

These opinions are very valuable coming from a man of Mr. Prince's experience, and his opinion as to the 10-wheel type will find favor in many directions, especially among those having the problem of 13 (and more) cars which must be handled on uncomfortably fast schedules. This question of type, however, needs to be very carefully stated or the arguments may be misleading. It is one thing to design a 10-wheel passenger engine with 70-in. driving wheels and a wide firebox for anthracite coal and quite another thing to adapt this type and 84-in. drivers to a bituminous coal engine with such a grate area as it ought to have. We would like to see how Mr. Prince would treat the 84-in. driver engine of the 10-wheel type for soft coal, giving the grates sufficient area to burn it in accordance with the ideas which are now so prominent in the minds of those who are trying to get away from very narrow fireboxes. Perhaps he would not insist on a deep-throat sheet and perhaps he would not be unwilling to raise the boiler high enough to get the rear drivers of a 10-wheel arrangement under the firebox. This appears to be the vital question in fast passenger engine design now: How to get a wide firebox for bituminous coal over large driving wheels?

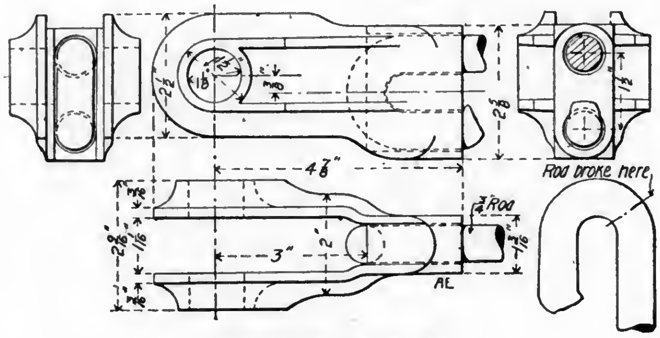
We should say that the 8-wheel type is best where it can be used; that the Atlantic type is the next step to be taken in order to get more heating surface than can be carried on 8 wheels and that the 10-wheel type comes in when the trains are both fast and heavy, too heavy for the Atlantic type to start. There seems to be a distinct field for the Atlantic type, between the 8-wheel and 10-wheel types, for specially fast and relatively light trains, such as the Atlantic City service and in similar work. The 10-wheel type is believed to be the one to be studied most by roads having heavy trains and burning soft and relatively poor coals, because it is here that the limitations of the fireman are confronted and this is rapidly taking position as an exceedingly important difficulty.

MALLEABLE IRON BRAKE JAWS.

Pere Marquette Railroad.

Referring to the test comparing the strength of malleable and wrought-iron jaws recorded on page 255 of our August number, Mr. B. Haskell, Superintendent Motive Power of the Pere Marquette, sends us a drawing of the malleable iron brake jaw extensively used on that system with exceedingly satisfactory results. The form of the jaw and the method of attachment of the rod are admirable and the test records show a remarkable and unexpected strength of malleable iron for this service.

Mr. Haskell also sends a letter written to him by Mr. Robert S. Cox, formerly General Manager of the Terre Haute Car and Manufacturing Co., upon the subject. This firm was building



**Malleable Brake Jaw.
Pere Marquette Railroad.**

cars for this road at the time, and these jaws were specified. The question of the strength of the jaws was raised and in December, 1898, Mr. Cox, without the knowledge of Mr. Haskell, submitted them to the Rose Polytechnic Institute for test. The results are interesting, and the strength shown by the malleable iron was a surprise to those who had questioned it. Mr. Haskell has used these jaws four years and has never found one of them broken. Some have been distorted in wrecks, but there has never been a failure in service. The letter by Mr. Cox describes the tests as follows:

"It will probably interest you to learn of some experiments that we made on one of your ¾-in. malleable brake jaw castings at the Rose Polytechnic Institute yesterday.

"The jaw was fitted with a ¾-in. iron rod and with a stub end of a lever fitted in the ends between the jaws. It was then put in a Rhiele testing machine and the pulling strain applied. The iron rod broke at 22,500 lbs. A bar of crucible steel was then applied in place of the ¾-in. iron and the jaw again submitted to the pull of the machine. This crucible steel broke at 35,100 lbs. strain and we were unable to find anything sufficiently strong to hold the jaw to the breaking point of the casting.

"At the conclusion of these tests, the jaw was apparently in as good condition as at first, with the exception that the holes for the pin were slightly elongated but not sufficiently to cause any difficulty in removing the pin. Both the iron and the crucible steel rods broke at the point indicated in sketch."

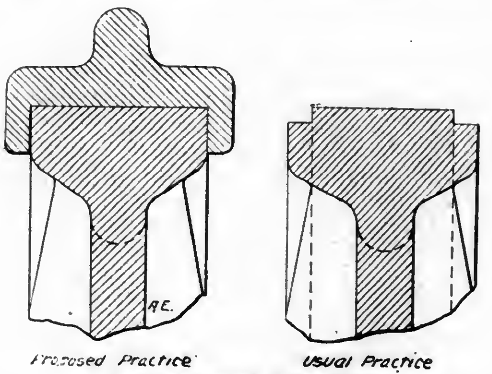
A recent test of a 600 horse-power "Simplex" gas engine at Seraing, Belgium, with high furnace gas gave the following results, as recorded in "The Engineer," London, June 29, 1900, page 662:

Brake horse power	573
Indicated horse power	790
Revolutions per minute	94
Number of admissions per minute	42
Mechanical efficiency, per cent	72
Gas per I. H. P. hour, cubic feet	89.8
Gas per B. H. P. hour, cubic feet	123.7
Heat value of gas in B. T. U. per cubic foot by Junker's calorimeter	102.4

LUBRICATION OF ECCENTRICS.

A good suggestion with reference to the form of locomotive eccentrics and eccentric straps, by Mr. F. W. Dean in an article in the "Railway Age" of June 15, attracted our attention as being worthy of trial because of the anxiety caused on some roads by hot eccentrics. We quote Mr. Dean as follows:

"Hot boxes in locomotive axles and pins seem to be as common as ever. Except in the case of foreign substances getting on the bearing surfaces, this is caused by defects in methods of lubrication. If a bearing is flooded with oil and the oil is actually on the bearing, hot boxes are impossible. The designs of eccentrics and straps, and of crankpins I have long held to be radically wrong. They are now made so that the centrifugal force carries the oil away from the bearing in the case of crankpins and sometimes in the case of eccentrics. The design of eccentrics also is such that three surfaces have to be fitted and taken care of. Where the eccentric is recessed into the strap



Lubrication of Eccentrics.

the centrifugal force keeps the oil on the main part of the bearing away from the other parts. If the side bearings were omitted and the strap overhung the sides of the eccentric, the eccentric would work better. Similarly, if crankpins were designed so that the bearing part of the box was on a larger diameter than the remainder of the pin; in other words, if the box clasped the pin to prevent side motion instead of the pin clasping the box, the centrifugal force would keep the oil where it is needed. This would make large pins, but they could have large holes through them and reduce weight in that way. In the case of driving axle journals it seems as if forced lubrication and filtration of oil, arranged so that it can be used again, would cure the difficulty."

Upon inquiry we find that Mr. Dean does not know of this form of eccentric and strap having been used on locomotives or in stationary work, except in the case of a stationary engine designed by him some years ago for use in South America and certain engines which he designed for mill work. It seems to us to be a very sensible way to construct eccentrics. We reproduce a free-hand sketch sent us by Mr. Dean.

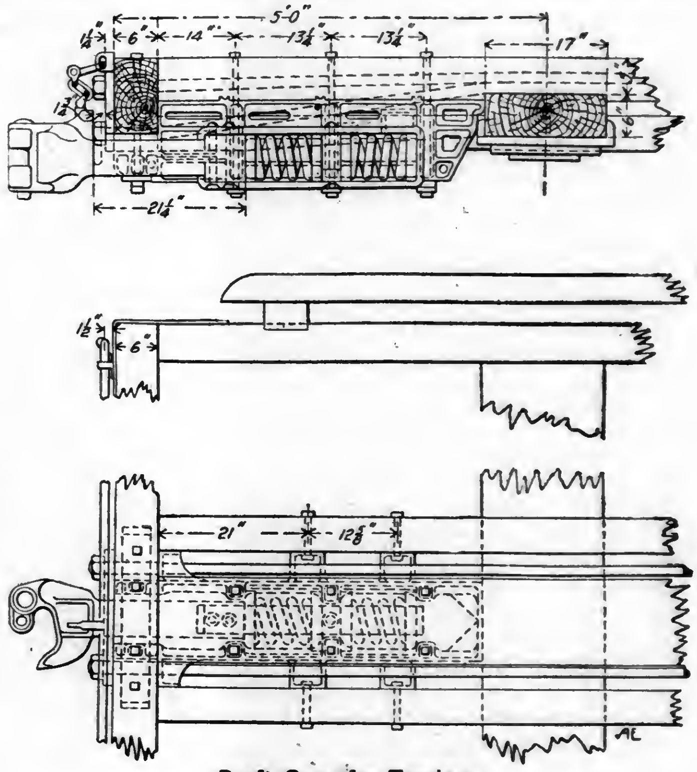
The number of railways in the hands of receivers on June 30, 1899, was 71, there being a net decrease of 23 as compared with the corresponding date of the previous year. According to the Interstate Commerce Commission reports the number of railways placed in charge of receivers during the year was 16, and the number removed from their management was 39. The operated mileage of the roads under receivers on June 30, 1899, was 9,853.13 miles, of which 7,225.62 miles were owned by them. Of the roads in the hands of receivers on the date named 10 had an operated mileage in excess of 300 miles, 10 between 100 and 300 miles, and 40 less than 100 miles. Complete returns for roads in the custody of the courts are not always available, but it appears that the capital stock represented by railways under receiverships on June 30, 1899, was about $220,210,688; funded debt, $306,486,740, and current liabilities, $59,180,823. These figures show a decrease of $43,926,703 in capital stock represented as compared with the previous year, and of $16,405,951 in funded debt.

TENDER DRAFT GEAR.

Louisville & Nashville Railroad.

Draft gear of tenders now receives more attention than was necessary when train loads were lighter, and many roads are considering the use of stronger forms. This arrangement, designed by Mr. Pulaski Leeds and Mr. F. A. Beckert, is illustrated as an example, showing that tender draft gear needs to be strengthened rather than because it is novel.

This drawing illustrates the recently adopted standard of this road. It replaces the simple and common arrangement employing a draft casting held to the end sill by the draft rods and including a Gould or Curtis M. C. B. coupler head. The new draft gear is like the M. C. B. arrangement except that it has tandem springs. It is similar to the draft gear of the 80,000-lbs. furniture and flat cars of this road. Mr. Beckert says that when applied to tenders the effect of the



Draft Gear for Tenders.
Louisville & Nashville Railroad.

draft gear upon the shocks and strains on the end structures of the cars nearest the engine is very marked. It also shows at once a tendency to reduce the trouble from breaking in two when the slack of the train runs out in going over summits. The jerks are cushioned by the springs instead of coming upon the tender frame through rigid couplings. A lateral motion of the draw-bar amounting to 2 in. is provided for in this gear. This motion is beneficial on curves and it should be provided to a proper extent in all couplings. This arrangement includes malleable iron draft castings which are designed to distribute the stresses upon the tender frame in such a way as to reduce the wear and tear to a minimum. The uncoupling device is the same as that employed in freight equipment.

Recent tests made of the electrolytic condition of the four great cables which support the Brooklyn Bridge disclosed the following facts: That these cables are great live wires through which currents of electricity are irregularly flowing, and that these currents are escaping to the ground through the eight heavy anchor-plates which are being eaten away slowly by this process of electrolysis.

TEST OF GAS ENGINE AT DIFFERENT LOADS.

Gas engines are not often tested at different loads, therefore the results of tests made by Mr. H. A. Soverhill, at the University of Illinois, and printed by "The Engineering Record" of July 21, are specially interesting.

The engine is the ordinary type of 10 horse-power, built by the Otto Gas Engine Company, of Philadelphia. It has a 5½x 12½ in. cylinder and runs at 310 revolutions per minute, the governing being by the "hit or miss" method. Careful arrangements for measuring the gasoline and securing other data were made and the temperature of the cooling water was taken by thermometers. A prony brake was used in determining the brake horse-power. The brake arm was proportioned in such a way as to lessen the work of computation by using the formula B. H. P. $= 2\pi lwn \div 33{,}000$, in which $\pi = 3.1416$, $l =$ length of brake arm, $w =$ weight or pull on arm, and $n =$ number of revolutions, and finding the value of l that will cause $2\pi l \div 33$ to drop out. This value was found to be 63.025 inches. By making the brake arm 63.025 inches long, the formula is B. H. P. $= wn \div 1{,}000$. The rear end of the brake is weighted so as to balance the weight of the arm, thus causing the scale readings to be brake load direct. Several tests were run and the readings given in the accompanying table were taken:

Tests of an Otto Gas Engine at Different Loads.

Length of test —hours.	R. P. M.	Explosions per min.	I. H. P.	B. H. P.	Mechanical Efficiency.	Gasoline per hour. per I. H. P.	Gasoline per hour. per B. H. P.	Jacket water. Degrees Fahr. In.	Jacket water. Degrees Fahr. Out.	Jacket water. Lbs per I. H. P. per hr.	Jacket water. Lbs. per B. H. P. per hr.	Brake load lbs.
1½	312	25	2.11	0	0	.622	....	90.5	160	....	...	..
1	311	49.6	4.21	1.56	37%	.54	1.46	78.8	167.5	....	...	5
1	313.6	58	4.99	2.27	45%	.66	1.43	64.4	159	84.1	185	7
1	310.9	76.5	6.72	4.04	60%	.567	.94	69.2	128	...	...	13
2	310	91	7.13	4.64	65%	.69	1.06	60.5	167	....	...	15
1	306	103.3	8.64	6.73	75.9%	.58	.748	68.4	199	45	35	22
1¾	308	132.3	10.57	8.30	78.5%	.64	.82	55.5	175	62.5	49	27
1	309.3	119	11.18	9.27	83%	.545	.647	54.6	157.5	63	52	30
1½	307	148.3	12.15	10.5	86.56%	.54	.64	63.6	118.5	.....	...	..

In conducting a test from which a heat balance was made, the exhaust gases were passed through a Baragwanath feedwater heater placed in a horizontal position. When the gases enter they expand nearly to atmospheric pressure, pass through the tubes and give up heat to the water at constant pressure. The thermometer placed in the exhaust pipe near the heater showed a temperature slightly above that of the water. The water was taken from the city mains and throttled by means of a globe valve until about the desired amount flowed through. The temperatures at entrance and exit were taken and the amount of water passed through weighed.

From the amount of water passed through the heater and its rise in temperature, it was found after correcting for the difference between the temperature of the atmospheric air and that of exhaust that 14,125 B. T. U. passed out through the exhaust during the test. There were 297.2 pounds of water used in the cylinder jacket and it was raised 103.1 degrees in temperature; that is, $297.2 \times 103.1 = 30{,}646.8$ B. T. U. carried away by engine jacket.

The brake horse-power was 9.27, which equals $9.27 \times 33{,}000 \times 30 \div 778 = 11{,}802$ B. T. U. The amount of energy consumed by friction was found by subtracting B. H. P. from I. H. P. and was found to be 2,687.4 B. T. U. A sample of the gasoline used was tested for its calorific value and was found to contain 17,200 B. T. U. per pound or $17{,}200 \times 3.94 = 67{,}778$ B. T. U. supplied during the test. This energy was distributed as follows:

	B. T. U.	Per cent.
Useful work	11,802	17.41
Friction of engine	2,687.4	3.95
Exhaust	14,125.2	20.98
Jacket water	30,600	45.15
Radiation, etc.	......	12.51
Total supplied		100.00

Mr. W. W. White, Air-brake Inspector of the Michigan Central, has resigned to accept a position with the International Correspondence Schools, and will have charge of instruction car No. 106.

THE MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.

This association will hold its thirty-first annual convention at Detroit, Mich., for four days, beginning September 11, with headquarters at the Cadillac Hotel. The following subjects will be presented:

"Hygene: Its Costs and Compensation." Dr. P. G. Conn.

"The Best Method of Conducting Tests to Determine the Relative Merits of Various Materials Used in Painting Railroad Equipment," F. S. Ball, Pennsylvania R. R., Altoona, Pa.; C. E. Copp, Boston & Maine R. R., Lawrence, Mass.

"The Best Method of Painting Locomotives; Also the Proper Method of Keeping Paint on Locomotives in Good Condition." Chris. Clark, New York, Chicago & St. Louis Ry., Chicago, Ill.; W. M. Joyce, Baldwin Locomotive Works, Philadelphia, Pa.; C. A. Cook, Philadelphia, Wilmington & Baltimore R. R., Wilmington, Del.

"The Best Method and Material for the Hardwood Surface of the Car Interior," Chas. E. Koons, St. Louis Car Co., St. Louis, Mo.; John T. McCracken, Jackson & Sharp Co., Wilmington, Del.; C. A. Bruyere, Canada Atlantic R. R., Ottawa, Ont.

"The Railway Master Car and Locomotive Painter," Samuel Brown, New York, New Haven & Hartford R. R., Boston, Mass.

"Is Terminal Cleaning, Where Thoroughly Practiced, a Factor in Paint Shop Economy?" J. A. Gohen, Cleveland, Cincinnati, Chicago & St. Louis R. R., Indianapolis, Ind.; B. E. Miller, Lehigh Valley R. R., Scranton, Pa.; A. R. Lynch, Pittsburgh, Cincinnati, Chicago & St. Louis R. R., Dennison, O.

"Can a New Wood Head Lining Be Prepared so as to Prevent Decay of Filler, Grain Raising, Etc.? If so, Give Method of Preparation," E. A. Cole, J. G. Brill Car Co., Philadelphia, Pa.; W. H. Dutton, Lehigh Valley R. R., Sayre, Pa.

"Does Burning Off Old Paint Have an Injurious Effect Upon the Surface or Upon the Future Painting?" Henry Block, Cleveland, Cincinnati, Chicago & St. Louis R. R., Brightwood, Ind.; J. A. P. Glass, Yazoo & Mississippi Valley R. R., Vicksburg, Miss.; Robert Shore, Lake Shore & Michigan Southern R. R., Cleveland, O.

"Uniform System of Freight Car Stenciling," J. H. Kahler, Erie R. R., Meadville, Pa.; W. O. Quest, Pittsburgh & Lake Erie R. R., McKees Rocks, Pa.; R. W. Scott, Seaboard Air Line R. R., Portsmouth, Va.

"Paint Shop Records and Accounts," W. T. Canan, Pennsylvania R. R., Tyrone, Pa.; F. G. Schaefer, Wheeling & Lake Erie R. R., Toledo, O.

Various queries.

That there is any advantage in facing locomotives in any particular direction in the erecting shop has probably not occurred to many of our readers, and because it seems to be a very sensible suggestion attention is directed especially to Mr. Whyte's remarks (June, 1900, page 188) about the position of engines in the erecting shop with reference to the windows. The front end of the engine should be toward the best light. This brings the smokebox, the cylinders and running gear into the most favorable position for light. The firebox end is toward the light in many shops, but as it is always necessary to use artificial light for interior firebox repairs, natural light at that end is not so important. This is one of the small details of shop arrangement which is often overlooked and is appreciated at once when attention is called to it.

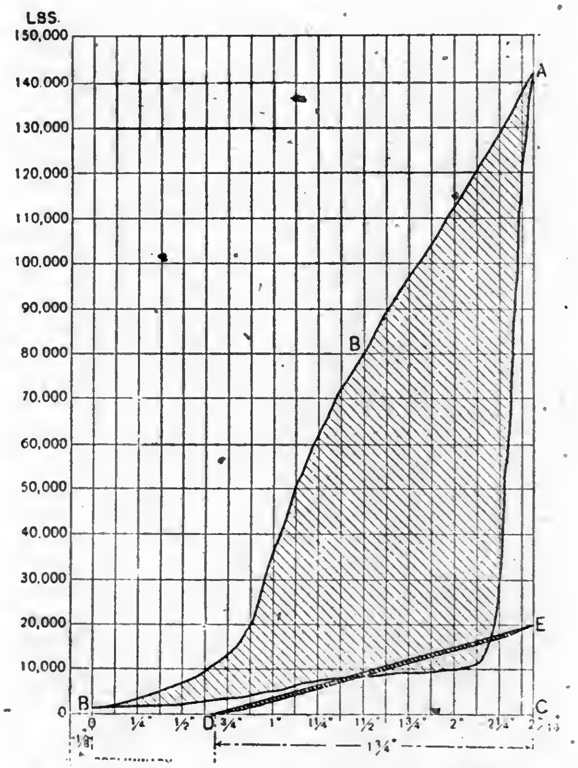
FRICTION AND SPRING DRAFT GEAR.

Graphical Comparison of Absorbing Capacity.

The necessity for providing increased capacity in draft gear for the absorption of energy is becoming more apparent as the weights of cars and trains increase, and one of the features of recent discussions of draft gear is an apparent appreciation of the deficiency of ordinary draft devices in this respect. We have already directed attention to the Westinghouse friction draft gear, and to its great power-absorbing capacity with absence of recoil, but have not been able to show this graphically until the accompanying diagram was received from the manufacturers of this draft gear.

This diagram shows the relative capacities of the ordinary draft spring (20,000 lbs. capacity) and the Westinghouse friction draft gear to absorb and dissipate buffing and pulling effects. It also shows the reactive effects of each.

The rising line, BB'A, represents the action of the Westinghouse gear under pulling or buffing stress, starting at an initial compression of about 2,000 lbs., as shown at the left of the diagram, and rising to a maximum stress of 142,000 lbs. The total area, BACB, represents the work done in arresting the buffing or pulling stress, while the lightly shaded area represents the amount of energy dissipated as heat by the frictional gear. The shaded portion is in this instance found to be 80 per cent. of the total area, BACB, only 20 per cent. of



Combination of Friction and Ordinary Draft Gear.

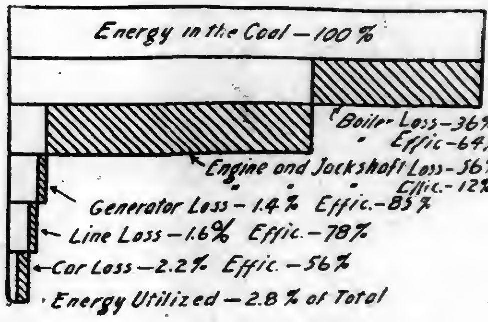
the energy of impact being given back in recoil as shown by the non-shaded portion of the area BACB.

The straight line DE represents the operation of an ordinary spring gear starting from zero compression. The area DEC represents the work done upon the spring during compression, and the narrow, heavily shaded area DE represents the amount of energy dissipated in frictional heating by the spring. In this instance the proportion of energy dissipated is only 7 per cent., as against 80 per cent. of the total energy in the case of the Westinghouse gear.

The diagram also shows in a very striking manner the maximum capacities of the two types of gear, the ordinary gear being shown at its maximum of 20,000 lbs., while the capacity of the Westinghouse gear is not exhausted until a compression of 140,000 lbs. and over has been reached.

SURPRISINGLY LOW EFFICIENCY OF ELECTRIC STREET CARS.

A series of tests of electric street cars in Ithaca, N. Y., was recently reported in the "Street Railway Review," by Mr. E. L. West. One of the interesting diagrams is reproduced in this engraving. It shows the distribution of energy for the entire system, giving the proportional parts of the total losses. The energy of the coal is taken at 100 per cent. and the sec-



Efficiency of Electric Street Cars.

tional portions of the diagram represent the various losses. At the right of each sectioned block are given the loss in per cent. of the total energy and the efficiency of that part of the system. The energy utilized in propelling the car under average working conditions is 2.8 per cent. of the total energy of the coal. The experiments were conducted under the direction of Prof. R. C. Carpenter of Cornell University.

F. W. DEAN ON LAPPED LONGITUDINAL BOILER SEAMS.

The practice of lapping plates of locomotive boilers for the longitudinal seams is strongly condemned by Mr. F. W. Dean in an article on locomotive progress in a recent issue of "The Railway Age." Mr. Dean speaks from a wide experience in designing large boilers and supports the view we take, that practice which is not correct in theory should be avoided unless there are the best of reasons for setting aside theoretical views.

"If anybody will make a study of boiler explosions," says Mr. Dean, "where the shell has been the initial part to rupture, or of boilers that have had cracks in the shell joints but have not yet exploded, he will be convinced that the lap joints are the causes of the explosions. I take every opportunity to reiterate this view. The lap joint with a bent inside covering plate is but little better, for it merely prolongs the life of the boiler a short time. The reason for this view of the case is that a lap joint necessarily throws the shell out of the circular form and causes the plate to bend at the edge of the joint with every change of pressure and finally wrecks it there. Everybody knows that if a wire or plate is bent back and forth in the fingers it will finally break off."

If there is no good reason for using lap joints, and we cannot now think of any, this view certainly ought to be considered by those using them.

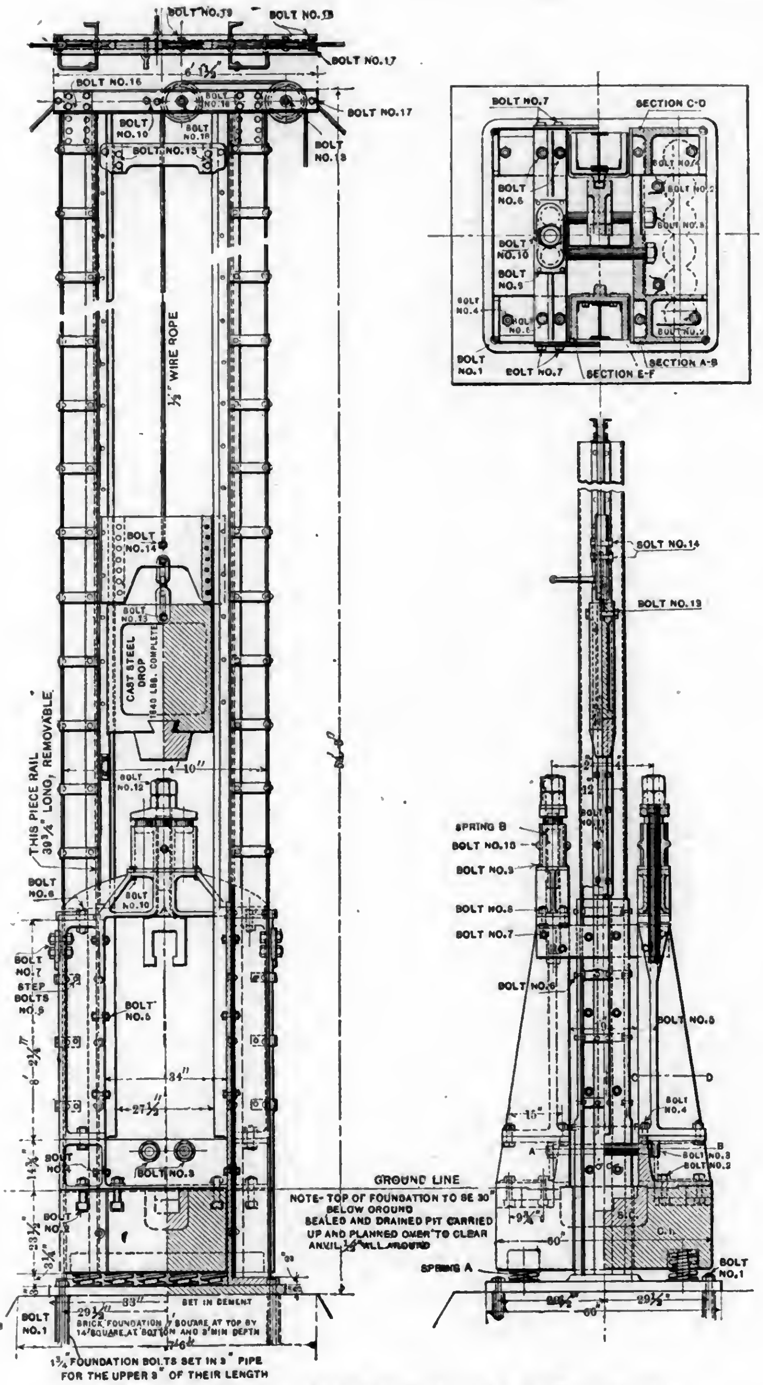
A milling cutter exhibited at Paris by the Eastern Railway of France has made a good record which is noted in the "American Machinist." The dimensions of the cutter are ¾ in. pitch, 9 13/16 in. diameter and 15¾ in. long. Beside the cutter is a box of chips cut by it in ten minutes from mild steel. The chips are all alike, the full length of the cutter, rolled up like straws and their weight is given as 15.4 lbs., which is at the rate of 92.4 lbs. per hour. The depth of the cut was 9/16 in., the feed 9/16 in. per minute and the circumferential speed of the cutter 32.8 ft. per minute. It is used in locomotive work.

M. C. B. ASSOCIATION DROP-TESTING MACHINE FOR COUPLERS.

As we have already noted, the Master Car Builders' Association committee on tests of M. C. B. couplers included in their report this year a thoroughly developed design for a drop-testing machine, which is illustrated by the accompanying engraving reproduced from the report.

After the convention of 1899 Purdue University, through Prof. R. A. Smart, with the approval of the late President Smart, and subject to the approval of the trustees of the University, made a proposition to the committee to the effect that a drop-testing machine of the approved design should be constructed by the University at its own expense under the direction of the association, and that when built it should be the property of the University and installed in its laboratory, to be at all times subject to the use of the association for official research. The University agreed to furnish the necessary assistance for carrying on tests, the machine to be at all times available for educational or commercial purposes. This, in short, is an arrangement similar to those under which the M. C. B. brake-shoe and airbrake testing apparatus have been installed in the laboratory, except that in this case the testing machine will be the property of the University.

This plan has been perfected and the testing machine is to be built. We reproduce the general plans in order to inform our readers of its chief features which are made clear in the engraving.



Recommended Drop Test Machine f r M. C. B. Couplers.

The new Hamburg-American liner "Deutschland" has again broken all previous records by making the voyage from New York to Plymouth at an average speed of 23.22 knots, the trip occupying 5 days, 11 hours, 43 minutes. She arrived at Plymouth August 14, and the speed is phenomenal considering that it was done on the second round trip.

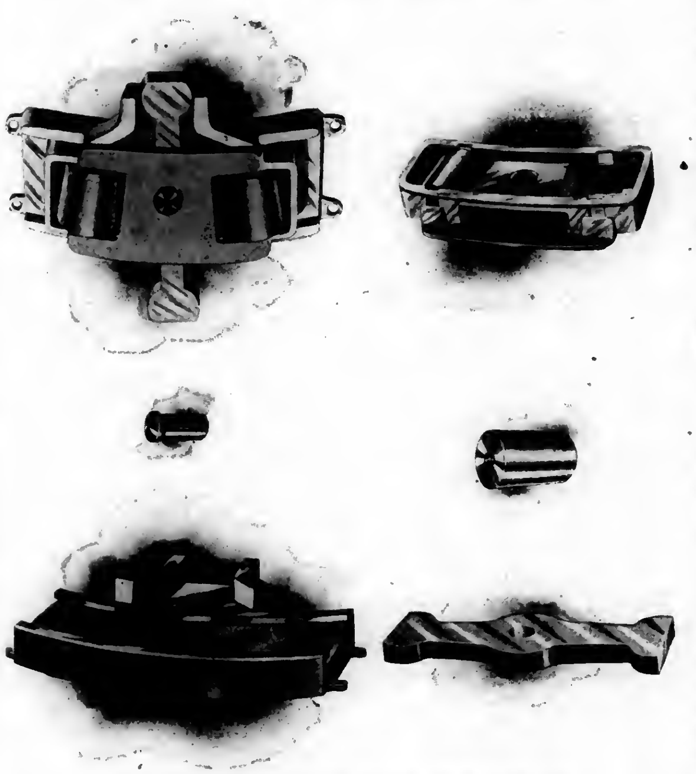
From a number of very carefully kept records of the weight of steel required for the skeleton of the average office building, the following formula was deduced, W = N.F. (15 + 7/10 N), in which W is equal to the total weight of metal in pounds, N the number of floors in the building, with the roof considered as a floor, and F the square feet in each floor. Then to find the weight of beams and fittings required in the floors we multiply 15 by the factor N.F and for the weight of columns multiply 7/10 N by the same factor. The sum of these weights is equal to W. This formula is offered as being sufficiently accurate for preliminary estimates on the weight of steel skeletons for an average building. It is taken from a paper by Mr. F. H. Kindl before the American Institute of Architects.

The J. G. Brill Co., Philadelphia, have won an important suit affecting their patents, the proceedings having been instituted against the Third Avenue Railroad of New York for the use, by this road, of a number of trucks employing spiral and elliptic springs, which were made by the Bemis Car Box Company, known as its "Standard" truck. The suit was vigorously defended by the Bemis Company, and after three years' litigation the decision, just handed down by Judge Shipman, sustained the validity of the claims of the Brill Company, and decreed, with costs, an injunction against the infringement of all of the claims and an accounting of profits and damages. The opinion contains the following: "The gist of the invention consists in combining with the frames of the truck and the spiral springs, another class of springs, viz.: elliptical springs, between the car body and extensions of the independent frame." The Brill Company intend to protect their rights in their claims and knowledge of the decision should prevent further infringement. We understand the decision to cover an arrangement of spiral and elliptical springs placed on the outer end of the truck frame.

THE IMPROVED SUSEMIHL ROLLER SIDE BEARING.

Improvements in roller side bearings for cars are particularly interesting at this time because the necessity of reducing flange wear and flange resistance is more thoroughly appreciated resulting from the increasing weights of cars and loads. In a previous issue of this journal the earlier form of this side bearing was illustrated, and we now present engravings showing an improved form of the bearing complete and in detail. The engravings are sufficiently clear to require little description. This is a development from 15 years experimenting, one idea of the inventor and designer being that it was necessary to provide means for compelling the rollers to roll and bring them back to their proper position between the bearings even when unloaded. The tendency for rollers to flatten unless compelled to roll is well understood.

There are but five parts to this bearing in addition to the upper and lower bearing plates, which must be provided in any side bearing. The carriage is a simple malleable casting, which confines the rollers, and, in conjunction with the lever, compels them to roll, always returning them to their central position even when the bearings are out of contact. This is done positively and without dependence upon springs. The lever is also of malleable iron; one end extends into a bracket projecting upward from the lower bearing plate and the other end into a bracket projecting downward from the upper bearing. Any change of position between the body and truck bolsters must, therefore, compel a corresponding motion of the carriage and consequently also of the rollers. The pin forming the connection between the lever and the carriage cannot be taken out until the upper bearing has been removed from the bolster. The rollers are about 2½ in. in diameter and 3 in. long; they are made of chilled iron. The bearing plates are also of chilled iron. If the car is jacked up or becomes separated from the truck, all the parts remain with the upper bearing and can not fall out or get out of place. This roller bearing is manufactured and sold by the Simplex Railway Appliance Company, Fisher Building, Chicago, from whom further information may be obtained.



The Improved Susemihl Roller Side Bearing.

TRANSPORTATION AT LOW COST.

American Pressed Steel Car Industry.

Reprinted from the Paris "Figaro."

It is a great mistake, common to all superficial minds, to think that all the progress which has been or may yet be made in the railroad industry must be limited exclusively to increasing the speed of trains and the comfort of passenger cars. Another improvement which is equally important, for it affects the vital interests of the entire human race, is the reduction to a minimum of the cost of transportation, and particularly of goods such as coal and ore, the circulation of which is to the industries of modern civilization what the flow of blood is to animal life.

In this matter it is safe to say that the record is indisputably held by the United States—the country of the whole world where railroad transportation is worked at the lowest cost. It is indeed in a great measure to this fact that the Americans owe the greater part of their formidable and increasing economical power.

The low cost of transportation naturally suggests a number of various contributing factors, such as the increase of the tractive power of locomotives, the improvement of the roads, etc. But among these faculties the one which appears to play the most important part is without question the increase of the capacity of the cars. It naturally stands to reason that the larger the cars the more goods they can carry, from which the following advantages result:

First.—Increased paying load in all trains.

Second.—Reduced number of cars in use, and reduced empty car movement; consequently a reduction in the capital engaged.

Third.—Shorter trains for a given tonnage, therefore increased paying load hauled by each locomotive.

Fourth.—Reduced switching service and cost of staff.

Fifth.—Increased capacity of main lines, stations and shops, which can accommodate a larger traffic without any enlargements.

Sixth.—The available capacity of a permanent way is utilized to a fuller extent.

However, the solution of the problem is not as easy as it might seem; one cannot go on increasing indefinitely the capacity of cars without at the same time increasing their dead weight in the same proportion. Ten years ago it was believed by engineers that the limit of the capacity of freight cars was reached in the wooden cars of 27,000 kilogrammes capacity, and many cars were still built of smaller capacity. But it was only an optical illusion. At the present time there are a large number of coal cars in use of 36,000 kilogrammes capacity, there are also many thousands with a capacity of not less than 45,000 or 50,000 kilogrammes.

It has been a complete revolution, which one may say has been brought about by one man, Mr. Charles T. Schoen, President of the Pressed Steel Car Company, to whom all the credit is due. Starting with the principle that the ideal object should be to transport the heaviest possible loads with the smallest possible dead weight, Mr. Schoen realized that to attain this object everything depended upon the selection of materials, and he decided to build cars entirely of pressed steel. The undertaking was not a light one, but owing to the mathematical precision of the designs, the principle of construction being to secure such a disposition of material that every part is proportioned to the service required of it, combining strength and lightness and avoiding the use of rivets and corner pieces.

Mr. Schoen has succeeded in building cars of an average capacity of 43 tons in which the ratio of dead weight to the total weight is 25 per cent. instead of from 35 to 50 per cent., as was the case previously. In a 45-ton car the saving in dead weight thus effected is at least 2,200 kilogrammes. Everybody will readily grasp the importance of this saving, as it requires the same tractive force and the same expenses to handle a dead weight as a paying load.

The majority of American railroads—not to speak of others—have adopted pressed steel cars, as in addition to the commercial advantages already mentioned their construction is much simpler, stronger and more lasting, and less costly to keep in repair. On the 1st of June last there were 18,038 of various

patterns in use, by the 1st of September next there will be 24,-138; but the number of pressed steel cars already ordered is at present 26,412, of an average weight of 15,000 kilogrammes and of a total capacity of 1,050,000 tons. It has been computed that from the one fact of using these cars in place of the old wooden car of smaller capacity, the saving effected on the said load of 1,050,000 tons, at the rate of 11,300 kilometers a year and 0.94 per kilometer ton, represented something like 26,000,000 francs—that is to say, that if all the traffic of the United States was carried in pressed steel cars of large capacity and light weight a yearly saving of 765,000,000 francs would result.

There is, therefore, nothing surprising in the fact that the Pressed Steel Car Company, whose business three years ago hardly amounted to $500,000 (2,500,000 francs) should have raised its production in so short a space of time to the incredible figure of $30,000,000 (150,000,000 francs), at the rate of 100 cars, or 1,500 tons of steel, per day. Three years ago the company employed 500 men, now they employ 10,000—that is to say, that something like 50,000 individuals are dependent upon its business for their livelihood.

That is what activity, backed by an untiring energy, and perseverance can be done by a single man, in spite of the greatest difficulties which alone would have discouraged a man of less determination. More fortunate than most inventors, who so seldom live to see the final triumph of their work, Mr. Charles T. Schoen has been fortunate enough to be able to enjoy the glory, power and riches which he has acquired through grit and hard work, and to see his dream completely realized.

His exhibit in Class 13 of pressed steel cars (Paris Exposition), which does so much honor to American industry, is truly sensational. There is not a doubt that it will attract the particular attention of the jury of awards. The fact is, it will interest everybody, since the great point in question is no more nor less than the reduction of the cost of transportation—that is to say, finally the emancipation of industry and living at a lower cost. EMILE GAUTIER.

BOOKS AND PAMPHLETS.

American Railway Engineering and Maintenance of Way Association. Proceedings of the first annual convention held in Chicago, March, 1900. Mr. L. C. Fritch, Secretary, Monadnock Building, Chicago.

This pamphlet contains the constitution, list of members, officers, committees and the outline of the committee work of the association, in addition to the papers and discussions of the annual meeting. The object of this association, as stated in the constitution, is "the advancement of knowledge pertaining to the scientific and economical location, construction, operation and maintenance of railroads." Its field is wide and its opportunities for usefulness great. The first volume of its official record in every way promises a most successful organization.

"The Work Ahead." An address delivered by George B. Leighton, President of the Los Angeles Terminal Railway. Constituting one of the series on railway subjects given before students of the Engineering Department of Purdue University, 1899. Published by the University of Lafayette, Ind. Also "Notes and Suggestions from Experience in the Motive Power Department of Railways." By Richard H. Soule, Late Western Representative of the Baldwin Locomotive Works, in the same series.

Those who follow the work of Purdue University have learned to look for the publication of the addresses of outside lecturers with anticipation. One of the ways in which this institution keeps in direct touch with the affairs in which the graduate is preparing to take his part is to secure the ideas of men who have been successful in their particular fields of the world's progress. Having these men to look at, listen to and to meet has an effect upon the student which may for a time be unconscious, but it is enduring. It opens his mind to thoughts which can not be received in any other way, and it inspires as well as instructs him. He may perhaps forget every word of these addresses, but he never loses the inspiration gained by contact with successful men. We are grateful to Purdue for the opportunity of sharing some of these benefits with the student. The addresses are put into convenient form, and we hope to preserve all of them.

One Hundred Years of German Bridge Building, by George C. Mehrtens, Professor of Engineering, Kornigliche Technische Hochschule, Dresden, Germany; from the German by Ludwig Mehrtens; 135 pp., 195 engravings. Berlin, 1900: Julius Springer.

This book was written by Professor Mehrtens to represent German bridge building at the Paris Exposition. It was prepared for six of the leading firms of German bridge builders, and its purpose was to illustrate the entire field of bridge building in that country. It treats of the development of this branch of engineering with reference to theory, design and erection and presents a large number of examples with descriptions. But 500 copies of the German edition are to be sold. It has been translated into English and French and 1,000 copies of each of the editions are to be presented by request to engineers interested in the subject. The author deals with iron bridges and their materials; he gives a history of girder construction and discusses the theory of bridges. He shows the improvements which have been made in iron bridge construction and describes the shops and methods of the six building concerns referred to. The work is carried out with taste and care, and as the publishers have done their part well, the volume is handsome in every respect.

"Dynamometers and the Measurement of Power: A treatise on the construction and application of dynamometers." By J. J. Flather. New edition, revised, with the addition of new chapters and some of the old ones rewritten. Published by John Wiley & Sons, New York, 1900. Price, $3.

This book was written to supply technical students and engineers with a detailed description of the construction and means of application of the various types of dynamometers employed in the measurement of power. The earlier edition has been revised for the purpose of adding new types of dynamometers and bringing the discussions up to the present state of knowledge on the subject. Besides rewriting the majority of the old chapters and giving considerable new material on the Venturi meter and on meter testing, five new chapters have been added, four of which are devoted to the measurement of electric power, which includes a general consideration of the subject, together with a discussion of electric measuring instruments and methods in use for determining the power and efficiency of direct and alternating-current motors. The fifth additional chapter is on the power required to drive machinery, of which the electric motor, in the group system and individually, is a prominent factor, and this part contains a very extensive and valuable table of the records of horse-power required to drive all ordinary machine-shop tools and wood-working machinery of various kinds and under different conditions. The scope of this book has thus been greatly enlarged and it is not only a very valuable book to the technical student, but to engineers in general.

The Chicago Pneumatic Tool Company have issued a special catalogue showing in excellent half-tone engravings their exhibit at the Saratoga conventions. A comparison of the exhibits of this company from year to year illustrates in an impressive way the growth of their business. This year the space occupied and the number of devices exhibited far surpassed previous efforts and the number of applications of pneumatic power to labor-saving devices continues to increase. This catalogue illustrates in detail the chief of the specialties of these manufacturers in wood and iron working tools, staybolt cutters, oil furnaces, flue cutters, air jacks and spraying machines for paint.

The Joseph Dixon Crucible Company, Jersey City, N. J., have issued a pamphlet of ten pages on the subject of graphite facings for foundry work. These facings are made in a large variety to suit various conditions of foundry practice, and they have as a basis the celebrated graphite controlled by this company. The object sought is to produce a facing for molds which will coat the sand and produce smooth finished castings. It must burn in order to secure the best results, and in burning, a thin film of gas is formed between the melted iron and the sand. This film must be sustained until the iron is cool in order to prevent the adhesion of the metal and the hard spots so frequently found in castings. Graphite is particularly well adapted to secure this result. Nine varieties are described in the pamphlet.

Fittings for Steam Vehicles, manufactured by the Ashton Valve Company, 271 Franklin Street, Boston, are briefly described in a small pamphlet which has just been issued. The devices described are pop safety valves, cylinder relief valves, steam or air gauges, duplex steam and air gauge, common water gauges, compression gauge cocks and Ashton pet cocks. Each of these is briefly described, and sizes and prices are given.

The Dustless Roadbed Process.—The Q. & C. Company have issued a small pamphlet, describing the dustless roadbed process, which consists of spraying a heavy oil over the roadbed by means of a sprinkler attached to an ordinary flat car. The oil is manufactured especially for this purpose by the Standard Oil Company. It has a high fire test and low gravity, which renders it free from danger of combustion. The faint odor which accompanies a fresh application of the oil is not disagreeable and entirely disappears in a few days. Many advantages and claims of economy are made for this oil. The rates for licenses under patents, including use of oil, also right to build and use patented sprinkling machinery to be attached to a flat car, can be obtained on application to the offices of the Q. & C. Company, 700-712 Western Union Building, Chicago.

Hand Book of Injectors.—This little book presents in a form convenient for the vest pocket, the information which users of injectors need to have at hand with regard to the construction and operation of this type of boiler feeder. It is issued by the Injector Department of Messrs. Wm. Sellert & Company, Philadelphia. Its purpose is to give assistance to those who would like to turn to a convenient reference in repairing an injector in a hurry, and it gives in condensed form the theory of injectors in general, and describes in particular the construction of injectors made by this firm. Tables from tests of locomotive injectors present figures of capacity, range and limiting temperatures, and a brief discussion of "How to use an injector to save fuel," near the end of the book, should be brought to the attention of those who handle injectors on locomotives and those who are directly responsible for the consumption of locomotive fuel.

The Torrey Ballast Car.—The Q. & C. Company have sent us a circular illustrating the Torrey Ballast Car, the control of which they have just acquired. The car is part of a very interesting and successful system for loading and distributing gravel and rock ballast from freight trains. Of the special features of the car, the double side doors and the type of locking device are examples. The Q. & C. Company have made arrangements with Mr. A. Torrey, Chief Engineer of the Michigan Central and designer of the Torrey Car, under which "they are prepared to grant licenses to railway companies and contractors, to manufacture or use cars built in accordance with this patent and solicit correspondence with all who are interested in this method of distributing ballast. Mr. Torrey's idea is to use these cars in local freight trains without requiring special work trains for distributing ballast. He also uses a special loading machine which seems to give satisfactory results.

The Morse Twist Drill and Machine Company, New Bedford, Mass., have issued a new catalogue of 120 pages illustrating and describing in great variety the product of their works. The engravings are excellent and each item is described in a table of dimensions which will be exceedingly convenient in ordering. The well-known specialties of these manufacturers are all shown, including a large variety of increase and constant angle drills, twist drills, reamers, chucks, milling cutters, dies, tube and other tools for machinists. We should say that every tool room, as well as shop manager's desk, should be supplied with a copy of this pamphlet. The plant of the T. & B. Tool Company, of Danbury, Conn., was purchased by the Morse Twist Drill and Machine Company in 1848. It has been moved to New Bedford and is now in operation. The style of drill formerly made by the T. & B. Tool Company will continue to be furnished under the name of "Constant Angle," the details of which are given in this catalogue. The catalogue is indexed. It is standard, size 6 by 9 inches, and is well printed on excellent paper.

Narrow Gauge and Industrial Railway Materials and Locomotives.—Arthur Koppel, manufacturer of narrow gauge railway equipment, 66 Broad street, New York, has sent us a copy of his "1900 Album," illustrating by aid of a large number of engravings the very extensive use to which the equipment he furnishes has been put in various parts of the world. Mr. Koppel has for years made a specialty of light railway equipment for factories, mines, docks, mills, furnaces, navy yards and, in fact, every sort of work requiring light railway equipment, whether steam, electric or rope driven. The album is divided into four parts, illustrating the Koppel equipments in use in Europe, Africa, Asia and North and South America. The descriptions are in six languages and the album conveys the impression of an exceedingly extensive business in all parts of the world where engineering operations are carried on.

Superior Graphite Paint is described in a little folder issued by the Detroit Graphite Manufacturing Company. This paint is made from Lake Superior graphite, from mines owned and exclusively controlled by this company. The success of this paint is said to be due largely to the peculiar character of the ore and the presence of certain valuable ingredients in it which causes the pigment to mix well and to stay mixed. We understand the chief advantages urged for this paint to be the following: Durability, freedom from chemical changes, absence of tendencies to crack or peel, ability to withstand heat, steam, vapor, water and gases. On iron work it is advocated for protection for surfaces which are covered up in construction so that they cannot afterward be inspected. It seems to be unaffected by the cements and plasters, lime or other materials used in building, and it is stated that even when spots of rust have already formed the paint, properly applied, will absorb the oxide and prevent further oxidation. It is particularly recommended for bridges, cars, docks, ships, roofs, smoke stacks; and when applied to woodwork it has important fire-resisting qualities. In the pamphlet are a number of engravings of buildings, bridges and ships upon which it has been applied with gratifying results. This is a well-known paint with an excellent record.

EQUIPMENT AND MANUFACTURING NOTES.

PNEUMATIC TOOL LITIGATION.

To the Editor:

Inasmuch as it has been called to our notice that a large number of users and prospective users of pneumatic tools are under the impression that suit has been entered against us by one of our competitors for infringement of their patents on account of the fact that they have brought suit against various pneumatic tool companies, we wish to notify the trade in general through your publication that we are not involved in any way, shape or manner in the present litigation, as our "Little Giant" pneumatic tools are fully covered by patents, the validity of which is not questioned by anyone.

Yours very truly,

STANDARD PNEUMATIC TOOL CO.

Chicago, August 15, 1900.

The American Locomotive Sander Company, of Philadelphia, has obtained control of the "Sherburne" sander, which was heretofore handled by the Automatic Track Sander Company, of Boston; this company having retired from the business and Mr. Sherburne becoming a stockholder in the American Locomotive Sander Company.

The Pearson Jack Company was known to have an extensive business in the sale of car repairing jacks and other specialties, but we are impressed with the fact that these devices are in demand abroad by the receipt of catalogues in French, German and Spanish. Mr. A. H. Richardson, manager of the company, is to be congratulated upon the success he has made.

The Richmond Locomotive Works have received an order for twelve 16 by 24-in. 10-wheel passenger locomotives from the Finland State Railways. This is the third order at these works from the Finland State Railways. It is a gratifying expression of satisfaction with American locomotives and with the product of the Richmond Locomotive Works.

The Ingersoll-Sergeant Drill Company of New York has received the Grand Prize at the Paris Exposition for their Mining Exhibit, the gold medal constituting this prize being the highest award given.

The Chicago Pneumatic Tool Company has engaged Mr. Fred F. Bennett as sales agent and manager of advertising, with headquarters at the main office of the company, Monadnock Block, Chicago. Mr. Bennett resigned his position as sales agent for the American Steel Casting Company and American Coupler Company of Chester, Pa., the change taking effect July 1. Mr. Bennett seems to be peculiarly adapted to his present position. His apprenticeship of several years was served on the Chicago daily papers as reporter and city editor, and later he was city editor of the Omaha Republican. Subsequent to this he was for many years Western Representative of the Railroad Gazette. His long experience in the journalistic field, his railroad acquaintance, combined with his thorough knowledge of trade publications, should make him a valuable acquisition to the staff of this company, and they are to be congratulated on securing his services in a department of their work for which he seems peculiarly qualified.

The Naval Electric Company, with offices at 95 Liberty Street, New York City, has been organized to succeed the B. & H. Electric Company of Dansville, N. Y., and New Haven, Conn. The same officers continue, the new name being more appropriate for the distinctive line of electrical business in which the company proposes to engage. F. G. Hall, Jr., A.S.M.E., is the Manager for the company, and I. E. Burdick, Secretary and Treasurer. Both gentlemen have been engaged in the electrical business for about ten years, and have devoted their attention more especially to the application of electricity to naval and marine purposes. These gentlemen have jointly invented an arc lamp for use under water, which is known as the Yale Submarine Arc Lamp. This lamp has proved its entire practicability for submarine use in connection with divers, and is being used by wrecking companies, dredging companies, dike and bridge builders, sponge and pearl fishers, in navy and dock yards, railroad docks, ship yards, and by the United States and Russian governments. It is being placed on the market by the company, who are negotiating for its adoption in foreign navies, and by various steamship companies at home and abroad.

At a recent meeting of the stockholders of the Consolidated Railway Electric Lighting and Equipment Company, held at 100 Broadway, New York, the following Board of Directors was elected: Walther Luttgen, Norman Henderson, C. G. Kidder, George W. Knowlton, Thos. J. Ryan, Isaac L. Rice, John N. Abbott, Aug. Treadwell, Jr. The vice-president and general manager of this company, John N. Abbott, was formerly General Passenger Agent of the Erie Railroad and subsequently for several years Chairman of the Western Passenger Association of Chicago. This company is a consolidation of the various companies heretofore engaged in the manufacture of electric lighting apparatus for all kinds of steam railway cars, the electricity being generated from the car axle while the car is in motion and furnished from a storage battery while the car is stationary. This system is known as the "Axle Light" system of electric lights and fans for railway coaches, and is in operation on various railway lines.

The Shickle, Harrison & Howard Iron Company, a company organized in 1867, having for the past few years done a very prosperous business, have found their old quarters in St. Louis (near the Union Station) inadequate to meet the growing demand for cast steel products, and have purchased a fine site in East St. Louis, and have built thereon one of the best and most up-to-date steel castings plants in the county. This has been in operation for some forty days, and is turning out an enormous amount of steel, and is working beautifully. This plant is a great addition to the steel-producing world of to-day. They make all kinds of railroad, street car, mining machinery, electric machinery and other kinds of castings, making a specialty of freight car trucks and body bolsters. The new plant has been visited by many prominent engineers and mechanical people, and pronounced one of the best of its kind in this country. This firm has also opened agencies in foreign countries, being represented by Sanders & Co., of London, who have a world-wide reputation. The Shickle, Harrison & Howard Company is in the front rank of the great steel producers. They are operating their plant in East St. Louis and the one in St. Louis. Mr. John W. Harrison, president, is one of the best known foundry men in the world. Mr. Geo. B. Leighton, president of the Los Angeles Terminal Company, is a very large owner in this property, and is a very bright, capable man. Mr. John M. Harrison, vice-president and general manager, is a prominent and progressive young St. Louis man, who has met with wonderful success in the management of this business. The sales department of the company is managed by Vice-President Clarence H. Howard, who has met with phenomenal success in the different positions which he has filled heretofore. He has many friends who recognize his business abilities and genial character.

The Pearson Jack Company, of Boston, inform us that they have acquired a license from the United States Car Moving Device Company, of Lowell, Mass., for the sole manufacture and sale in the United States and foreign countries, of the United States Car Pusher and that in the future this device will be handled with the regular line of specialties of the Pearson Jack Company. We have seen a number of letters from those who have used this car pusher and they are universally favorable. The device is compact and self-contained and is admirably adapted to the requirements of those who desire something which will enable them to move cars easily through short distances.

Switzerland, "The playground of Europe," is visited annually by over 15,000 American tourists and invalids. Why? While the Alps have isolated peaks such as Mont Blanc (15,781 ft.), and the Matterhorn (14,836 ft.), the mean elevation of the highest Alpine chain is from only 8,000 to 9,000 ft. Colorado possesses more than 120 peaks over 13,500 ft. in altitude, of which no fewer than 35 peaks range from 14,000 ft. upward. In the whole of Europe there are not over 12 mountain peaks of note. The highest village in Europe is Avers Platz, in Switzerland (7,500 ft.); the highest inhabited point in Europe is the Hospice of St. Bernard in Switzerland (8,200 ft.). In Colorado the mining town of Leadville, with 15,000 inhabitants, is 10,200 ft. above sea level; other mining camps are still higher, and some gold and silver mines are worked at an altitude of over 12,000 ft. The highest wagon road in Europe is said to be the Stelvio road in Switzerland (9,170 ft.). In Colorado the railroads cross the crest of the continent at Fremont Pass (11,328 ft.), Marshall Pass (10,852 ft.), and Tennessee Pass (10,433 ft.). Switzerland does not possess, even in the famous St. Gothard line, any railroad engineering surpassing, if equaling, these. There are wagon roads over numerous passes in Colorado ranging from 12,000 ft. upward, the highest being Mosquito Pass (13,700 ft.). In Switzerland the cog railroad from Vitznau to the summit of the Rigi Kulm (5,900 ft.) has a length of four and a half miles, in which the ascent is 4,072 ft. In Colorado the cog railroad from Manitou to the summit of Pike's Peak (14,147 ft.) has a length of eight and three-quarter miles, in which the ascent is 8,100 ft., or an average of 846 ft. per mile, the maximum grade being 1,320 ft. One class of Switzerland's finest scenery is along the Via Mala, the Schyn Pass and Urnerloch. In Colorado, the Canon of the Arkansas, with the Royal Gorge, the Black Canon of the Gunnison, the Canon of the Rio de las Animas, the Canon of the Grand River, and others, are all much longer, quite as grand as and more varied in character than the best passes in Switzerland. The walls of the canons of the Grand River, the Gunnison and the Arkansas rise to a sheer height of more than 2,000 ft. As Colorado can be reached by at least one railroad—the Burlington—in one night from either Chicago or St. Louis, it is hard to understand why more Americans do not travel West instead of East in search of health and pleasure.

WANTED.—Copies of the "American Engineer, Car Builder and Railroad Journal," one of the June, 1896, issue. also one of the January and May issues of 1898. Fifty cents will be paid for a complete copy of each sent to the Editor, 140 Nassau Street, New York.

AMERICAN ENGINEER AND RAILROAD JOURNAL.

OCTOBER, 1900.

CONTENTS.

"NORTHWESTERN TYPE" PASSENGER LOCOMOTIVE.

Chicago & Northwestern Railway.

Comparison with Standard Passenger Engines on New York Central.

The new wide firebox passenger engines for the Chicago & Northwestern, built last summer by the Schenectady Locomotive Works, and called "Northwestern Type," are specially interesting and the design is believed to be an important one which is likely to exert a strong influence toward wide fireboxes for soft coal. We illustrated the engine on page 237 of our August number, and by courtesy of Mr. Quayle and the builders we are now permitted to direct attention to some of the important details.

The results of the service so far obtained seem to indicate that this design is a step in the right direction. The reports which we have seen are entirely satisfactory. The engines perform their work with ease and with an increase of comfort to the fireman in maintaining steam pressure. They are almost smokeless, even when burning western coals. Perhaps the two fire doors contribute to this, but it seems clear that the large grate makes it possible to secure advantageous conditions of combustion which are unusual in locomotives burning soft coal.

Before being delivered to the owners one of these engines was "broken in" on the New York Central, and the opportunity was taken to compare it with one of the regular "Empire State Express" engines, an 8-wheel type, and with one of the heavy 10-wheel passenger engines, No. 2,012. The three engines were pooled on two trains, Nos. 18 and 51, for five days, with the results given in the accompanying table, which Mr. A. M. Waitt of the New York Central has kindly supplied us:

Locomotives Compared on the New York Central.

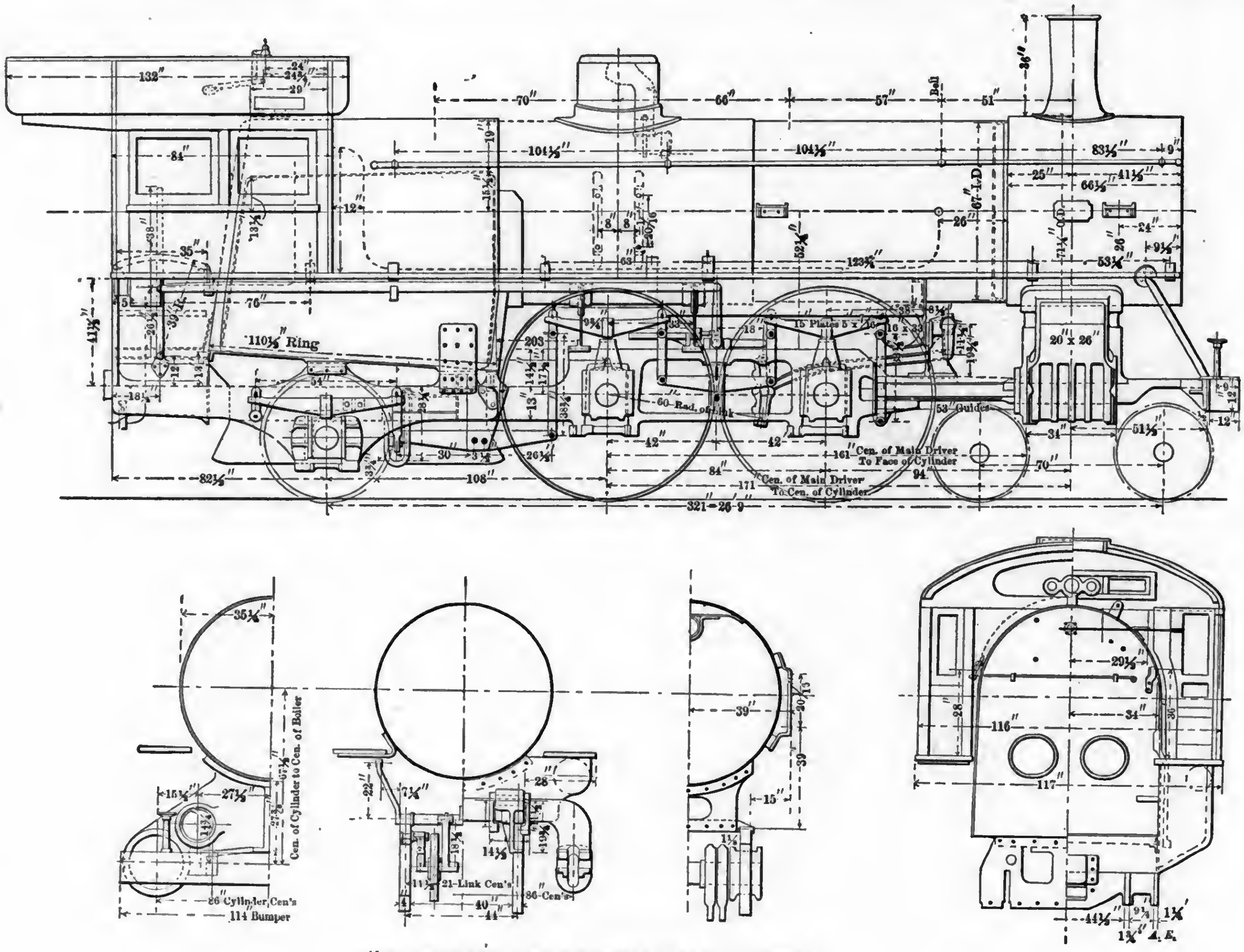
Engines.	N. Y. C. No. 870.	N. W.	N. Y. C. No. 2012.
Type	8-wheel.	Northwestern.	10-wheel.
Weight in working order	131,000 lbs.	160,000 lbs.	168,900 lbs.
Cylinders	19x24	20x26	20x28
Drivers	70 in.	80 in	75 in.
Heating surface	1,974 sq ft.	3,015 sq. ft.	2,908 sq. ft.
Grate area	30.7 sq ft.	46.2 sq. ft.	30.5 sq. ft.
Boiler pressure	190 lbs.	200 lbs.	190 lbs.

The Northwestern type gave excellent results, although the trains were too light to show its best work. Its record was nearly 8 per cent. better than that of the regular 8-wheel engine for this service. It should be said that the 10-wheel engine, No. 2,012, was also at a disadvantage because of the very light trains. Mr. Waitt expressed confidence in the wide firebox and believed that this engine was a step in advance, indicating the lines which future fast passenger engines should take. He was particularly well pleased with the comparative smokelessness of the Northwestern engine. Twelve cars weighing, with the engine, 710 tons were hauled from New York to Albany by this engine, August 31, on the Adirondack train, No. 55, and between Poughkeepsie and Albany, 70 miles, the time of the "Empire State" was made, which on the next day engine No. 2,012, the 10-wheel type, failed to do.

Mr. Quayle is an advocate of large heating surfaces and great boiler power. Herein seem to be the features of this engine, and the grate contributes a large part of the boiler capacity. The difference between this and the Atlantic type is in the outside arrangement of the boxes of the trailers. This was done to spread the points of support at the firebox, reduce the overhang of the firebox at the sides and support the mud ring at its extreme width. It gives a wider base to the engine at the back end and should produce excellent results in smooth riding. The inside journal bearings for the trailing axle have been considered by many as a serious objection to the wheel arrangement of the Atlantic type, and we have heard complaints of hard riding, tending to confirm this opinion, but whether the difficulty cannot be overcome in an easy way is an interesting question. This is rather important, because of the complication of parts when the boxes are placed outside. A certain advantage, however, of the Northwestern arrange-

Relative Performances of "Northwestern Type" and New York Central Passenger Engines. Compared on New York Central Trains Nos. 18 and 51 (Empire State Express) between New York and Albany.
Records of Five Consecutive Days.

Engines	N. Y. C. No. 870.	N. W. No. 1017.	N. Y. C. No. 2012.	Difference between No. 870 and (In actual results.) No. 1017.	No. 2012.	(In percentage.) No. 1017.	No. 2012.
Totals for five days.							
Lbs. coal for trains, and used in round house	89,830	80,950	94,390	8,880	4,560	......	......
Number of cars hauled 143 miles	66	64	69	2	3	3 less.	4.5 more,
Ton miles	430,114	420,277	439,296	9,867	9,152	2.3	2.1
Average, five days.							
Lbs. coal per car hauled 143 miles	1,361	1,265	1 368	96	7	......	......
Lbs. coal per round trip	17,466	16,190	18.878	1,776	912	9.8	5.1
Lbs. coal per car mile	9 52	8 84	9 56	0.68	0.04	7 1	0.4
Lbs. coal per ton mile	0 2088	0.1925	0.2142	0.0163	0.0054	7.8	2.6



"Northwestern Type" Passenger Locomotive.

Fig. 1.—Side Elevation and Sections.

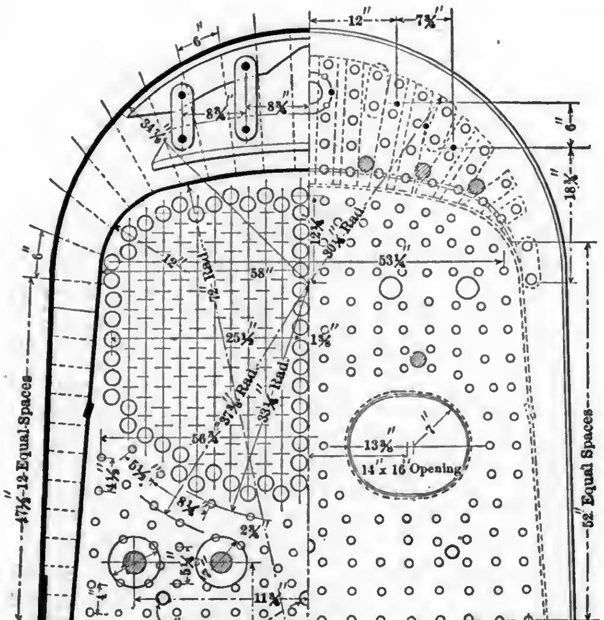


Fig. 3.—End View and Section of Firebox.

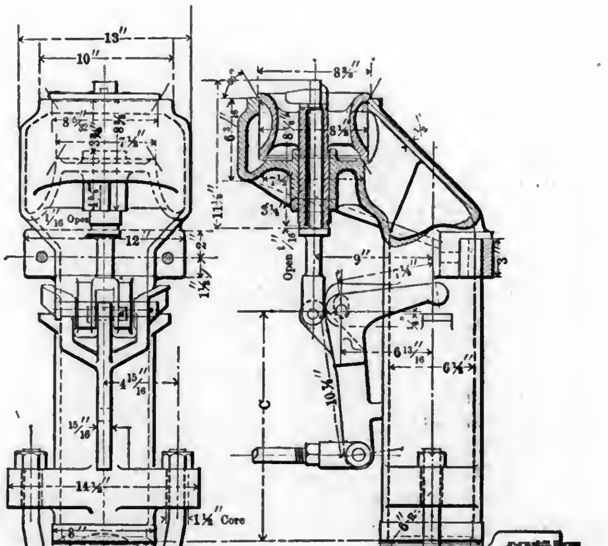


Fig. 6.—Throttle and Attachments.

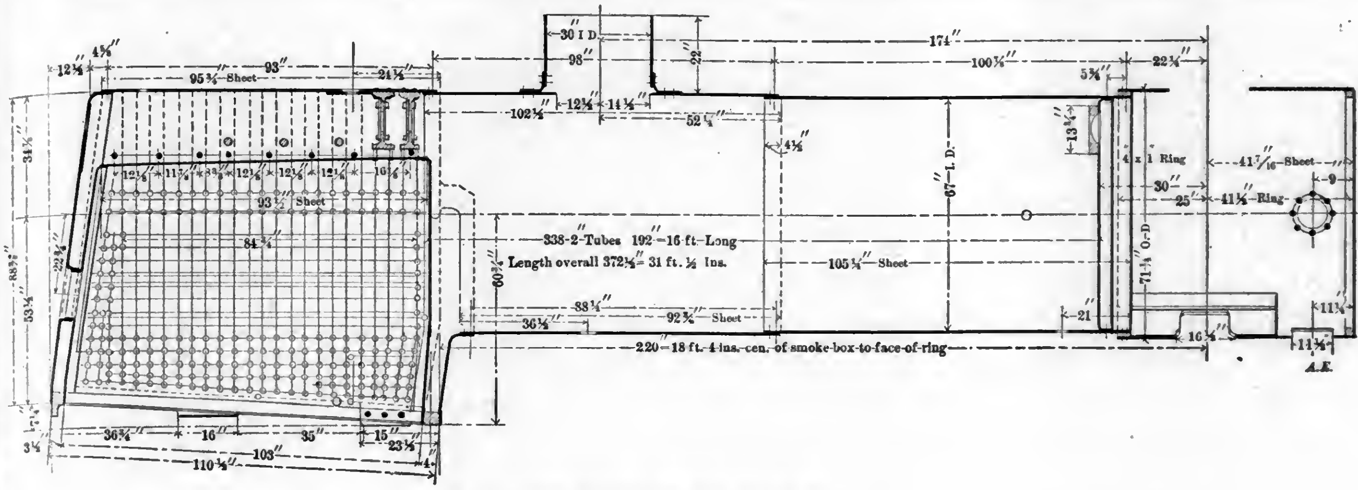


Fig. 2.—Longitudinal Section of Boiler.

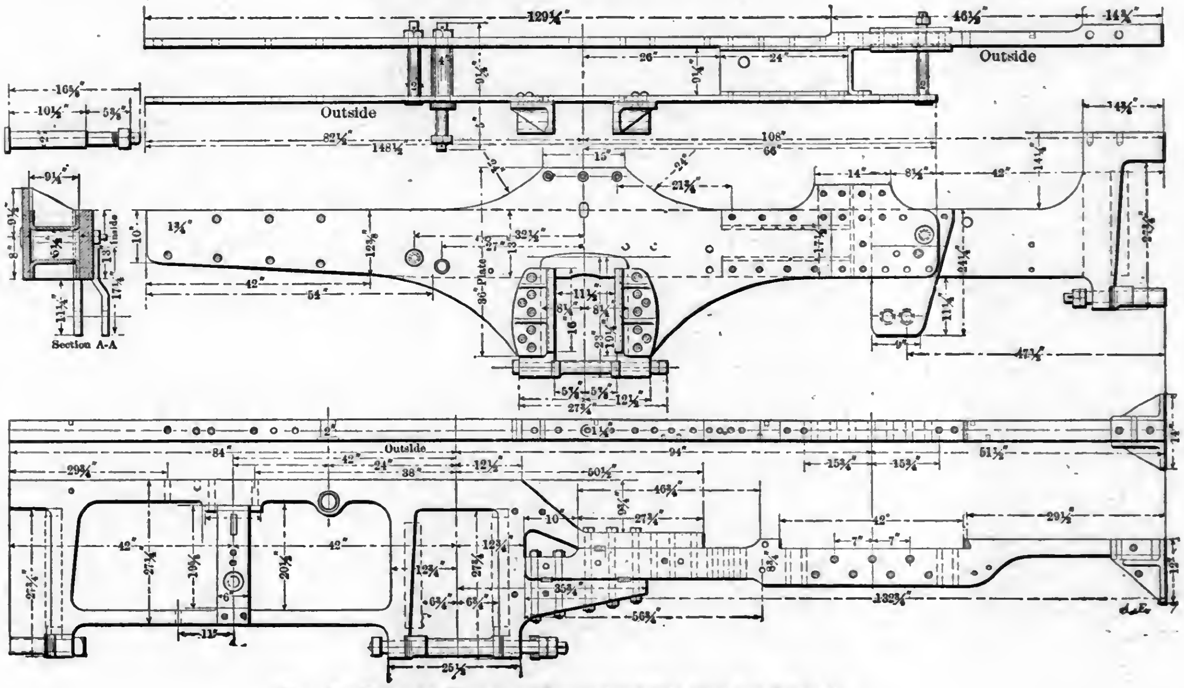


Fig. 4.—Frames Showing Supplemental Trailer Frames.

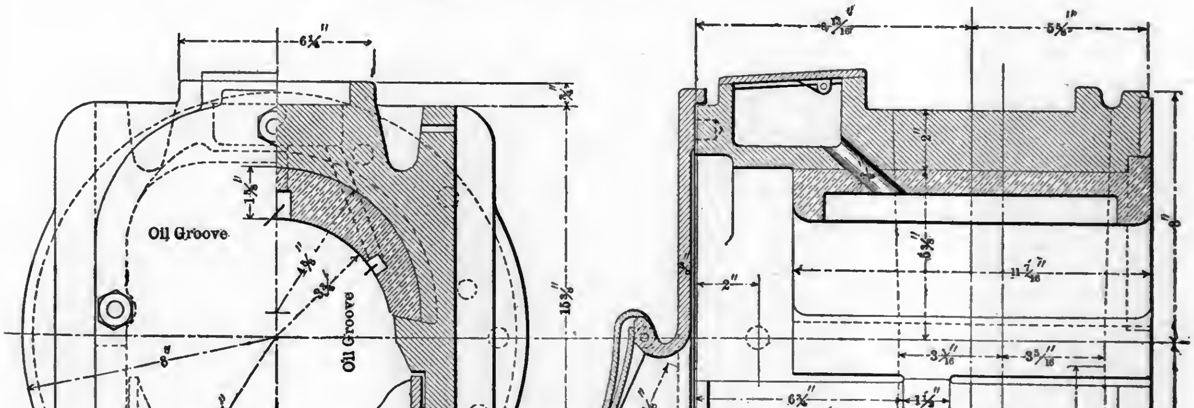


Fig. 5.—Journal Boxes for Trailing Axle.

THE "NORTHWESTERN" TYPE COMPARED WITH VARIOUS ATLANTIC TYPE LOCOMOTIVES.

Number	1015	1591	838	601 5	209	....	....	512	....	820	....	....	....
Road	C. & N. W. "N. W." Type.	C. B. & Q. Atlantic.	C. M. & St. P. Atlantic.	Wabash. Atlantic.	Can. Pac. Atlantic.	Lehigh Val. Atlantic.	Atlantic City, Atlantic.	Erie Atlantic.	C. R. R. of N. J. Atlantic.	P. R. R. Atlantic.	Atlantic French State.	Atlantic Westphalian Rys.	Great Northern of England.
Weight — On drivers	90,000 lbs.	85,850 lbs	71,600 lbs.	86 000 lbs.	80,000 lbs.	81,800 lbs.	78 600 lbs.	84,290 lbs	80,000 lbs.	101,450 lbs.	71,905 lbs.	66,140 lbs.	69,440 lbs.
Weight — On truck	35,000 lbs.	40,200 lbs.	40,000 lbs.	....	....	29,000 lbs.	37,000 lbs.	36,545 lbs.	....	38,125 lbs.	32,700 lbs.	34,170 lbs.	33,600 lbs.
Weight — Total	162,000 lbs.	159,050 lbs.	140,700 lbs.	159,585 lbs.	159,000 lbs.	140,950 lbs.	113,000 lbs.	151,000 lbs	141,000 lbs.	173,450 lbs.	139,055 lbs.	128,970 lbs.	129,920 lbs.
Wheel base — Driving	7 ft. 0 in.	7 ft. 6 in.	6 ft 9 in.	7 ft. 0 in.	7 ft. 3 in.	6 ft. 7 in.	7 ft. 3 in.	6 ft. 7 in.	7 ft. 3 in.	7 ft. 5 in.	7 ft. 3 in.	80 11/16 in.	6 ft. 10 in.
Wheel base — Total	26 ft. 9 in.	27 ft. 1 in.	25 ft. 6 in.	24 ft. 5¾ in.	25 ft. 11½ in.	24 ft. 0 in	26 ft. 7 in.	24 ft. 9 in.	26 ft. 5 in.	26 ft 6½ in.	26 ft. 5 in.	28 ft. 6⅛ in.	26 ft. 4 in.
Cyl. — Dia. x stroke	20 in. x 26 in.	13½ & 23x26 in.	13 & 22 x 25 in.	19 in. x 26 in.	13½&23x26 in	19 in. x 26 in.	13 & 22x26 in.	13 & 22x19 in.	13 & 22x26 in.	20½ x 26 in.	17¼ x 26 in.	19¼ x 22⅝ in.	19 in. x 24 in.
Cyl. — Spread	86 in.	87 in.	87 in.	....	....	83 in.	....	....	....	85½ in.	....	22 7/16 in.	95 in.
Driving wheels — Diam	80 in.	81¼ in.	78 in.	73 in.	84 in.	76 in.	84¼ in.	76 in.	84¼ in.	80 in.	84¼ in.	78 9/32 in.	81 in.
Driving wheels — Cent. diam	74 in.	78 in.	72 in.	....	....	70 in.	....	....	....	....	78 in.	....	....
Driving wheels — Material	Steel.	Steel.	Steel.	Steel.	Steel.	Steel.	Steel.	Steel	Steel.	Steel.	Steel.	....	....
Driving journals	9 in. x 12 in.	8 in. x 12 in.	8 in. x 12 in.	8 in. x 9 in.	8½ x 12 in.	8½ x 11 in.	8½ x 12 in.	....	8½ x 12 in.	Main 9½ x 13 in.	8 in. x 10 in.	8⅛ x 8.86 in.	....
Eng. Truck — Wheels	36 in.	36 in.	36 in.	33 in.	36 in.	36 in.	36 in.	....	36 in	36 in	36 in.	37½ in.	43½ in.
Eng. Truck — Journals	6 in. x 10 in	5½ in. x 10 in.	5½ in. x 10 in	5 in. x 9 in.	6 in. x 10 in.	5½ x 9 in.	5½ x 12 in.	....	5½ x 12 in.	5½ x 10 in.	6 in. x 10 in.	6 5/16 x	....
Frames, width	4 in.	5 in.	....	4 in.	....	4 in.	....	....	....	4	....	....	....
Boiler, type	Straight.	Straight.	Straight.	Ext. Wag. Top.	Belpaire.	Wide firebox.	Wide firebox.	Wide firebox.	Wide firebox.	Modified Belpaire	Straight.	Wag. top.	Straight.
" dia., O. D., 1st ring	68 in.	62 in.	60 in.	62¼ in.	62 in.	61 in.	58¾ in.	61 in.	58¾ in.	67 in.	58 in.	57 in.	56 in.
" pressure	200 in.	210 in.	200 in.	210 in.	210 in.	180 in.	200 in.	200 in.	....	185 in.	213 in.	191 in.	175 in.
Firebox	102⅛ x 65¼ in.	121 x 40⅜ in.	103 in. x 42⅛ in.	101½ x 42½ in.	110 x 42⅝ in.	114⅝ x 80⅝ in	114 x 96 in.	96 x 96 in.	114 x 96 in.	104 x 96 in.	120 x 42 in.	60 x 72⅝ in.	....
Tubes, No. of and diam.	33[illegible]—2 in.	248—2¼ in.	264 2 in.	300—2 in.	284—2 in.	265—2 in.	278 1¾ in.	271—2 in.	278—1¾	353—1¾ in.	246—2 in.	259—1⅞ in.	191—2 in.
" Length	16 ft. 0 in.	16 ft. 0 in.	15 ft. 0 in.	14 ft. 3 in.	15 ft. 0 in.	15 ft. 1 in.	13 ft. 0 in.	15 ft. 0 in.	13 ft. 0 in.	13 ft. 0 in.	15 ft. 1 in.	15 ft. 5 in.	13 ft. 0 in.
Cyl. volume	9.46	....	....	8.52	....	8.52	....	....	....	9.93	7.03	7.54	7 88
Heating surface — Tubes	2816.91 sq. ft.	2,320 sq. ft.	2,073.5 sq. ft.	2,223 sq. ft.	2,231 sq. ft.	2,081.2 sq. ft.	1,614.9 sq. ft.	2,116.6 sq. ft.	1,614.9 sq. ft.	2,204.4 sq. ft.	1,925.4 sq. ft.	....	1,302 sq. ft.
Heating surface — Arch tubes	28.27	....	....	....	....	....	Com. cham. 53.8	....	....	....	....	....	....
Heating surface — Firebox	170.70	180	171	200	170	148.9	136.4	168.8	190.2	218	170.4	....	140
Heating surface — Total	3015.88 sq. ft.	2,500 sq. ft.	2,244.5 sq. ft.	2,423 sq. ft.	2,401 sq. ft.	2,230.2 sq. ft.	1,808.1 sq. ft.	2,285.4 sq. ft.	1,805.1 sq. ft.	2,320.4 sq. ft.	2,095.8 sq. ft.	1,848.3 sq. ft.	1,442 sq. ft.
Grate surface	46.27 sq. ft.	35 sq. ft.	30 sq. ft	29.92 sq. ft.	32.25 sq. ft.	63.97 sq. ft.	76 sq ft.	64 sq. ft.	76 sq. ft.	69.33 sq. ft.	35 sq. ft.	30.25 sq. ft.	26.75 sq. ft.
Trac. power	22,100	16,827	15.502	22,951	16,978	18,900	14,352	15 911	....	23,430	16,066	17,195	15,915
Trac. power ÷ G. S.	477.63	480.7	516.7	767.08	526.45	295.4	188.8	248.61	....	339.4	459.03	568.43	594.95
G. S. ÷ cyl. vol	4.89	....	....	3.5	....	7.5	....	....	....	7	4.97	4.01	3.44
H. S. ÷ cyl. vol	318 8	....	....	284.39	....	261.76	....	....	....	233.67	298.13	245.13	183
H. S. ÷ G. S	65.18	70	75	81	74	35	....	....	23.75	33.4	59.88	61.10	53.9
Center of boiler fr. rail	109½ in.	108 in.	104½ in.	103 in.	106.5 in.	106¼ in.	105¼ in.	....	....	109	....	97 7/16	95
Trailing wheels	48 in.	54¼ in.	54 in.	57 in. (Est.)	58 in.	....	54¼ in.	....	54¼ in.	56 in.	54¼ in.	37.4 in.	43½ in.
" journals	7½ in. x 12 in.	8½ in. x 12 in.	7 in. x 12 in.	8 in. x 9 in.	8½ x 12 in.	7 in. x 12 in.	7 in. x 12 in.	....	7 in. x 12 in.	7 x 11¾ in.	8 in. x 10 in.	5½ x	....
" weight	37,000 lbs.	33,000 lbs.	29,000 lbs.	....	....	30,050 lbs.	....	30,175 lbs.	....	33.755 lbs.	34,450 lbs	28.660 lbs.	26,880 lbs.
Center truck to 1st driving axle	94 in.	104 in.	100 in.	91¼ in.	98½ in	95 in.	104 in.	....	....	101 in.	....	104¾ in.	99 in.
Length of side rod	84 in.	90 in.	81 in.	84 in.	87 in.	79 in.	87 in.	....	....	89 in.	87 in.	80.71 in.	82 in.
Cent'r rear drivers to cent'r trailers	108 in.	90 in.	84 in.	84 in.	87 in.	77 in.	87 in.	....	....	89 in.	87 in.	123⅝ in.	96 in.
Tender, frame	Channel, 8-W.	Channel, 6-W.	Channel, 8-W.	Chan l 8-W.	Chan'l, 8-W.	Chan'l, 8-W.	Chan'l, 8-W.	Chan'l, 8-W.	....	Chan'l, 6-W.	Chan'l, 8-W.	....	6-W.
" wheel diam	36 in.	42¼ in.	33 in.	36 in.	40 in.	36 in.	36 in.	....	36 in.	42 in.	36 in.	....	49½ in.
" journals	5 in. x 9 in.	6¼ in. x 10 in.	4¼ in. x 8 in.	4¼ in. x 8 in.	5 in. x 9 in.	....	5 in. x 8 in.	....	5 in. x 8 in.	5 in. x 9 in.	4¼ in. x 8 in.	....	....
" capacity, galls	5,200	5,000	4,500	4,500	5,400	4,000	3 500	6,000	3,500	5,000	3,600	3,527	3,650

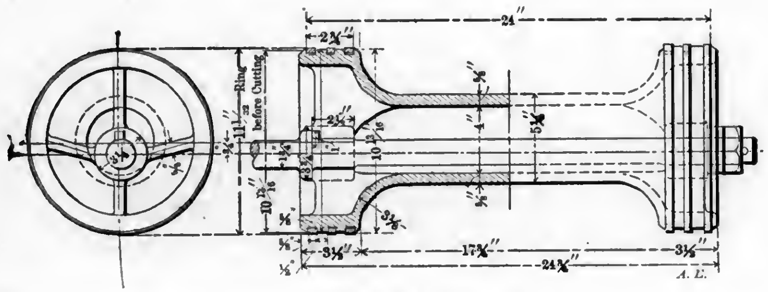


Fig. 7.—Piston Valve.

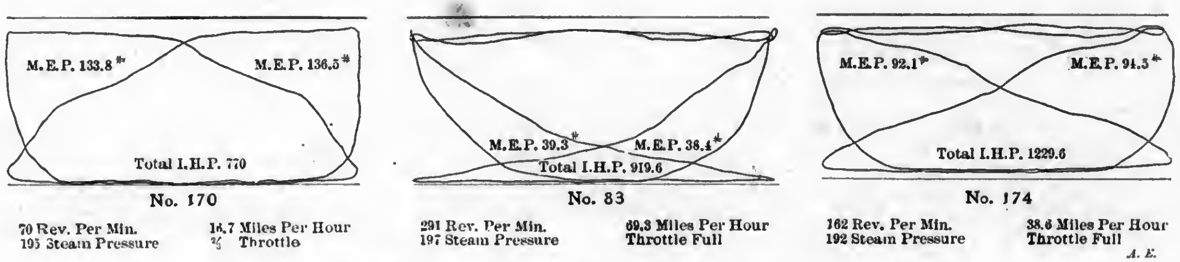


Fig. 8.—Indicator Cards from "Northwestern Type" Locomotive.

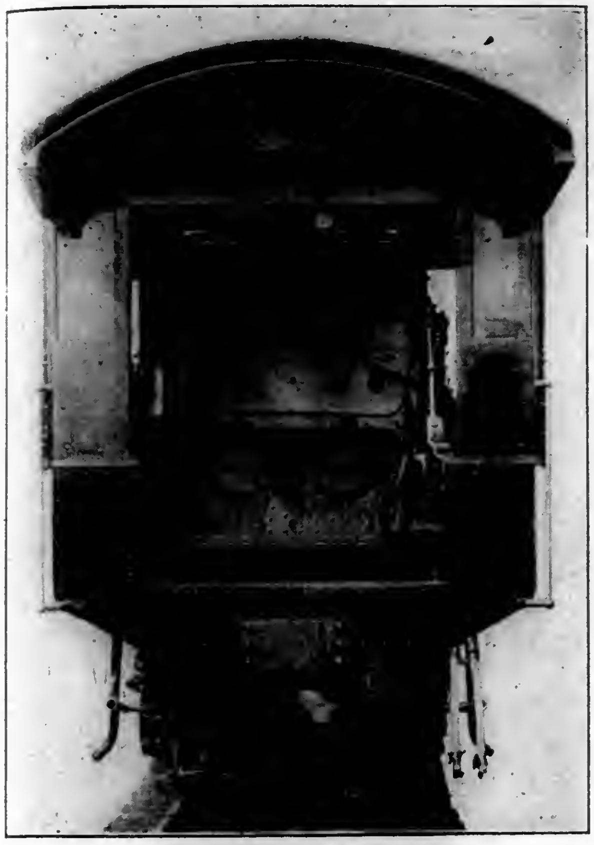


Fig. 9.—Rear View of Cab.

ment is a good space for the ashpan. The supplemental frames, shown in Fig. 3, give a very satisfactory support to the mud ring, and they probably weigh less than the large steel castings used on the C., B. & Q. "Prairie Type" (American Engineer, April, 1900, page, 103).

The side elevation, Fig. 1, illustrates the general features. The rear elevation and section and the photograph, Fig. 9, show that in spite of the width of the firebox, 5 ft. 5¼ in., there is ample room in the cab. The two fire doors are 14 by 16 in. in size, and the deck is wide enough to render the firing easy. The equalizing system is, for the driving wheels, as usual, and in front of the trailers a cross equalizer connects the two sides and takes care of the offset to the trailer springs. The side view also shows the method of supporting the firebox and the construction of the valve motion connections to get past the front driving axle. The motion is not changed at the rocker shaft, because both of the rocker arms extend downward and the valve has internal admission. The driving wheels are 80 in. in diameter in order to give high speed, and the cylinders are 20 by 26 in. in order to start quickly. The next step was to provide boiler power to give endurance.

The boiler is seen in Fig. 2, and the firebox in Fig. 3. It needs no comment, except to direct attention to the long tubes, 16 ft., the sloping back head and straight sides of the firebox and the thickness of the sheets, which are as follows: Crown sheet, ⅜ in.; tube sheet, ½ in.; side and back sheets, ⅜ in. The mud ring has lugs forged upon its lower face to take the weight and receive the fastenings. The outside firebox sheet is in a single piece, while the inside sheet is in three parts for ease in renewing the side sheets.

There is nothing unusual about the main frames, but the outside supplemental frames shown in Fig. 4 are specially interesting. They receive the weight of the boiler at the back end and over the trailer boxes. These boxes are carried in heavy pedestals of cast steel bolted to the outside faces of the supplemental frames. The method of securing the short and long frames together at the rear is shown in the upper view of Fig. 4. The trailer boxes are shown in Fig. 5. The whole front is in a single piece and removable after taking out the screws. Owing to the possibility of heating, due to the proximity to the firebox the engines were arranged to lubricate these bearings in several different ways in order to determine the best method. One had the oil groove in the top of the brass, another had grooves in the sides of the bearing only, and another had the oil groove at the top of the bearing and also four plumbago plugs fitted to cavities at the sides. The holes for the plumbago are ⅞ in. in diameter, and ⅜ in. deep. The hub bearings of these boxes are faced with babbitt.

The throttle design is that of Mr. A. S. Vogt, Mechanical Engineer of the Pennsylvania. By comparing Fig. 6 with the designs for the Pennsylvania Class E-1 engines on page 170 of our June number the resemblance is apparent. The throttle not only has a large leverage for its initial opening and a faster movement for its remaining movement, but careful attention has been given to the directness of the steam passage into and through the throttle pipe. It will be noticed that this valve opens only at the top of the pipe, and the valve being hollow there is no sacrifice of area while the dryest steam only is taken. All who have seen this throttle speak in high praise of it.

The piston valves, Fig. 7, are 11 in. in diameter. They have internal admission and the packing is in the form of three narrow plain snap rings, which is considered by these builders to be the most satisfactory packing for piston valves. The edges of the valves are beveled off outside the rings in order to make the rings give a clear cut-off edge. This valve is hollow, light and very simple.

Some interesting indicator cards taken from one of these engines seem worthy of reproduction. We have selected three, which show the effects of good steam and exhaust passages, high horse-power and low back pressure.

Cards Nos. 170 and 174 were taken on train No. 15 between Albany and Utica on the line of the New York Central, and No. 83 was taken while the engine was pulling the Empire State Express at 69 miles an hour.

For convenience in comparing this engine with others having similar wheel arrangement the table on page 304 is reproduced by courtesy of Mr. L. R. Pomeroy, of the Schenectady Locomotive Works. It is at once apparent that this is a wonderfully powerful engine when compared with others in this list. It does not, however, represent the limit of capacity for four coupled wheels, and one of its strongest advantages is that the boiler may yet be made more powerful by using longer tubes and wider grates. It is but a step from this design to one like Mr. Delano's "Prairie Type," but with three pairs of 80-in. drivers and 20-ft. tubes. Such an engine will soon be built by another road and it will be worth watching.

Mr. John A. Secor, Engineer-in-Chief of the General Power Company, New York, read a valuable and timely paper before the New York Railroad Club, at its September meeting, upon the subject of internal-combustion engines. After reviewing the history of this type of engine, and showing its advantages over steam in economy, the question of fuel was considered, and the very great advantages of oil over gas and the lighter petroleum products were clearly brought out. The speaker outlined the qualifications of a successful internal-combustion engine and led up to his solution of the problems in the engines of his design. These use oil, which is available everywhere, they are of the vertical type and most simple in construction. They do not require a "carburetter" and they appear to be admirably adapted to railroad work in shops and elsewhere.

The Marconi system of wireless telegraphy has been definitely adopted for the British navy, and, according to "The Engineer," 25 sets have been purchased. Marconi gets $500 royalty per year on each set. There seems to be no question among British naval men that this is the best wireless system.

FOUR-WHEEL PASSENGER CAR TRUCK.

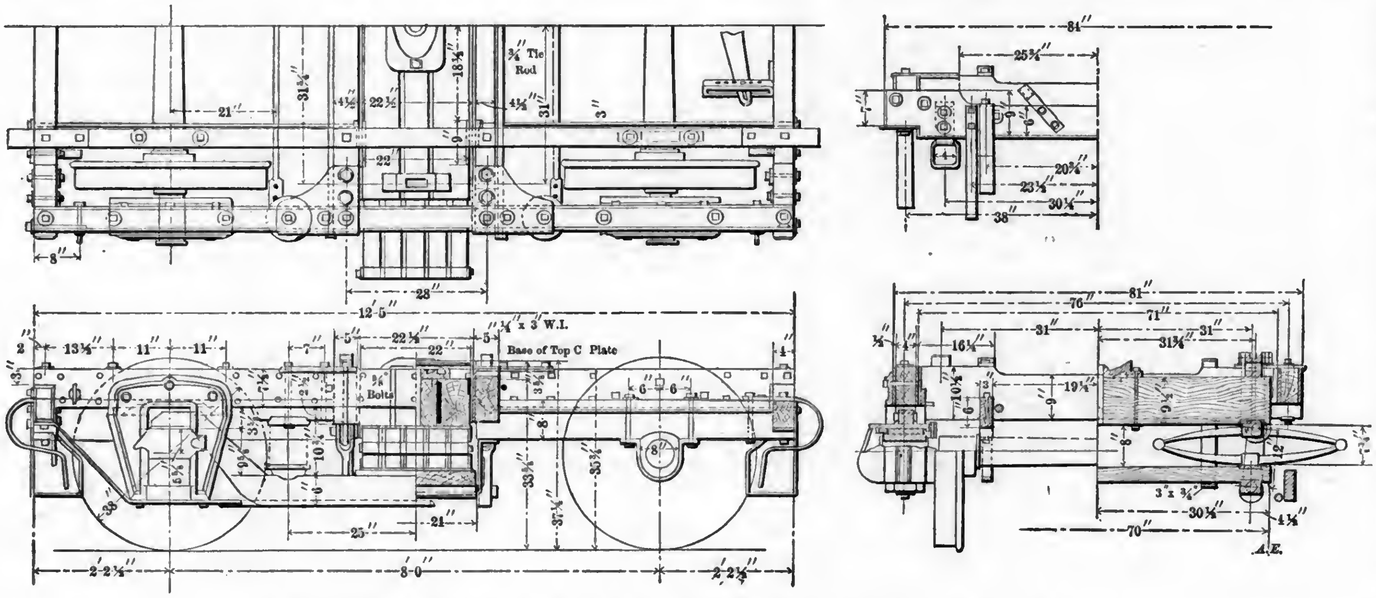
With 5 by 9-inch Journals.

Illinois Central Railroad.

This truck at the first glance appears to be merely a design for the use of 5 by 9-in. journals in passenger equipment. It is not for novelty in design that it is presented, but because it represents an effort at improvement in passenger car practice which has now fairly begun and seems likely to lead to rather radical changes.

total weight, and at present prices the difference in cost will probably be about $500 per car in the first cost. This is accompanied by an important saving in maintenance of two steel wheels, two axles, pedestals and bearings, and a large number of accessory parts in each truck, to say nothing of the frames themselves. In a train of 15 Pullman cars, provided the four-wheel truck can be used, the saving in weight would be about 93,000 lbs., or more than the weight of one of the heavy cars.

Other roads, following the example of the Illinois Central, have already considered the subject, and several entirely new passenger truck designs may be expected. It is important to



Four-Wheel Truck, with 5 by 9-in. Journals. For Heavy Passenger Cars.
Illinois Central Railroad.

This truck, which is illustrated through the courtesy of Mr. Wm. Renshaw, Superintendent of Machinery of the Illinois Central, and Mr. W. H. V. Rosing, his assistant, was designed to enable that road to use four-wheel trucks in place of present ones with six wheels, under buffet and smoking cars, in the hope that they will be found sufficiently satisfactory for use under other cars now having six-wheel trucks. The object is to save weight and expense of construction and repairs. If the riding qualities of the six-wheel truck can be secured with a saving of four wheels, two axles and the accompanying parts for every car, the idea will at once be accepted as a marked improvement in a direction in which there has been little change for a number of years. The six-wheel trucks for heavy passenger cars are very strong and in many ways satisfactory. They have, however, grown in weight and in number of parts entirely out of proportion to the loads they carry, until the present truck of the Pullman type is a complex and complicated combination of wood, iron and steel, the number of parts in which must be seen as spread out for assembling in order to be appreciated. Wooden members originally sufficed for the frames. Steel reinforcements were added as the weights of cars increased, and very little thought has been given to the question of cost and weight as long as good service was given. It is hoped that this new design will be successful enough to bring to the subject of trucks the attention it merits.

The earlier six-wheel trucks had 3¾ by 7-in. journals. These have given place in many cases to 4¼ by 8-in. journals, and to get sufficient strength for carrying the weight on four wheels Mr. Renshaw uses the 5 by 9-in. M. C. B. journal and axle. The equalizers are 6 in. deep and the frames are made stronger. No other novelties are seen in the drawing.

About 3,000 lbs. per truck are believed to be saved in the reduce the weight of passenger trains in every practicable way. In order to insure complete success in this direction, however, improvements in the spring arrangements will be needed, or the four-wheel type will fall short of the six-wheel in smooth riding.

Since this description was written we have received from Mr. A. M. Kittredge, Vice-President of the Barney & Smith Company, builders of the new trucks for the Illinois Central, the following information. The new four-wheel trucks, with 5 by 9-in. journals, weigh 29,900 lbs. per set, and the cost to-day would be about $1,250 for two trucks. The standard Illinois Central six-wheel trucks weigh about 36,100 lbs. per set, and they would cost to-day about $1,825 per set. This places the saving in weight per car at 6,200 lbs. and in cost at $575, to say nothing of the saving in maintenance.

CLOSING OF THE ROGERS LOCOMOTIVE WORKS.

Upon the death of Mr. Robert S. Hughes, President of the Rogers Locomotive Works, Mr. Jacob Rogers, the chief owner, who has not been active in the management for ten years, decided that he did not wish to continue the business on account of his age and the necessity for new equipment to place the plant in a favorable position for competing with the other builders. The plant at Paterson, which has been in operation since 1852, was never favorably situated, having no railroad connection, and the continuance of the business probably appears to Mr. Rogers a serious undertaking. Efforts have been made to buy and continue the works, but they have, we believe, been unsuccessful. Many of our readers will learn with regret that the works will close when the present orders are completed, probably in December.

LOCOMOTIVE DESIGN.*

By F. J. Cole, Mechanical Engineer, Rogers Locomotive Works.

Traction Force and Adhesion.

Unlike other forms of steam engines or motors of various kinds, the power of a locomotive is not usually estimated as of so many horse-power, either for comparison or for determining the weight of trains which can be hauled, but rather as having a certain amount of tractive force in pounds. In order to properly proportion the boiler, so that ample grate area, heating surface, etc., is provided to generate steam in sufficient quantity, it is often desirable to know the amount of horsepower which a locomotive can develop at different speeds, but the tractive force of an engine is the usual measure of its power.

By the tractive force is meant the push or pull of the cylinders on the crankpin, reduced to the point of contact of the tire and the rail. By making suitable deduction for the power required to overcome the internal friction of the engine, and also the power required to move the engine and tender, the tractive force will equal the drawbar pull at the rear of the tender. The theoretical tractive force is expressed by the well-known formula:

$$T = \frac{d^2 \times L \times P}{W}$$

where T = tractive force in pounds
d = diameter of cylinder in inches
L = stroke in inches
W = diameter of driving wheels.
P = Mean effective pressure in pounds.

The power of the two cylinders at the point of contact between the wheels and rail is given in the above formula, the form in which it appears being an abbreviation or cancellation of the entire formula

$$T = \frac{2\ (d^2\ .7854) \times L\ 2}{W\ 3.1416} = \frac{d^2 \times L}{W}$$

Tables No. 1 and No. 2 give the tractive force per pound of mean effective pressure on the pistons for various sizes of cylinders and wheels. In calculating the maximum tractive force it is customary to assume that the mean effective pressure at slow speeds—say under 200 ft. piston speed per minute—is equal to about 85 per cent. of the boiler pressure. For example, a locomotive having 20 x 28-in. cylinders with drivers of 62-in. diameter and 200 lbs. boiler pressure, would have a tractive force of $180.6 \times .85 \times 200 = 30{,}700$ lbs. While the M. E. P. is usually taken at 85 per cent. of the boiler pressure, this is only an approximation, as the range is between 83 and 88 per cent. Table No. 3 shows the various percentages of pressures from 140 to 250.

Probably the simplest and clearest way to consider the power of a locomotive is to use the same unit of work, "the foot-pound," which is the universal measure of work or energy among English-speaking people.

An impression seems to exist that under certain conditions, a locomotive is capable of pulling up a grade a load greater than can be accounted for by the usual rules governing the tractive power, and that the generally accepted formula does not always account for all the power which an engine can exert. Accounts of phenomenal train loads have occasionally been published by means of which the writers have endeavored to prove that the energy exerted was greater than could be accounted for by ordinary rules, even if the mean effective pressure was equal to that in the boiler. If the work performed by the locomotive is estimated like other kinds of work in foot-pounds, it may, perhaps, be more clearly understood.

The thrust of both the pistons multiplied by four times the stroke in feet is the number of foot-pounds of work done during one revolution of the driving wheels. This divided by the circumference of the wheel in feet, will equal the number of foot-pounds of work the engine is capable of exerting. For instance, if the cylinders are 20 in. in diameter and 28 in. stroke, the drivers 62 in. in diameter, average steam pressure 170 lbs. on the pistons during the entire stroke:

$$F = \frac{2 \times 20^2 .7854 \times 2.33 \times 2 \times 170}{16.23} = 30{,}700 \text{ lbs.}$$

or exactly the same result found by the usual formula.

The tractive force of a locomotive may be briefly described as the force exerted to propel it and to haul the train to which it is coupled. To find the proper diameter of cylinders when tractive force, stroke and diameter of driving wheel is given:

$$D = \sqrt{\frac{T\,W}{l}}$$

when T = the tractive force per pound of M. E. P. Example: Required the diameter of cylinder for a tractive force of 129 lbs., when the diameter of the driving wheel is 72 ins. and the length of stroke is 26 ins. Then:

$$D \sqrt{\frac{T\,W}{2}} = \sqrt{\frac{129 \times 72}{26}} = 18.9$$

To find the diameter of the driving wheels,

$$W = \frac{D^2 L}{T}$$

To find the length of the stroke,

$$L = \frac{TW}{D^2}$$

To find the tractive force,

$$T = \frac{D^2 L}{W}$$

If the tractive force exceeds the adhesion the drivers will slip. Speaking in a general way, the weight on the driving wheels should be from 4 to 4½ times the maximum average tractive force, when the M. E. P. is taken at 85 per cent. of the boiler pressure.

In the proceedings of the Master Mechanics' Association for 1887 the committee appointed to report on the proper proportion of locomotive cylinders and driving wheels recommend the following ratios of tractive force to weight on drivers:

Passenger engines, 4 to 1.
Freight engines, 4.25 to 1.
Switching engines, 4.50 to 1.
Diameter of driving wheels to be taken with tires half worn out.

Since this report was made pneumatic sanding devices have come into very general use, by means of which small quantities of sand may be blown under the wheels for comparatively long distances without exhausting the supply, as formerly was done when hand-operated sandboxes were used exclusively. Taking this into consideration, together with the fact that fractional parts of an inch are introduced into the wheel diameters by assuming the tires to be half worn out, it is more convenient for comparison in calculating the tractive force to consider the wheels to be the full diameter and not half worn out. On this basis, even with the most approved form of sanding apparatus, it is not considered good practice to make the total weight on the drivers less than four times the tractive force when the M. E. P. is assumed to be 85 per cent. of the boiler pressure. For very heavy engines built for exceptional service, good results can often be obtained with a ratio of 4 to 1 or a co-efficient of adhesion of 0.25. For general freight or switching service the ratio should not be less than 4.2 or a co-efficient of 0.238.

The co-efficient of adhesion between the revolving steel tires and steel rails, which may be described as the resistance to

*For previous article see page 176.

TABLE NO. 1.—TRACTIVE POWER PER POUND OF MEAN EFFECTIVE PRESSURE.

Diameter of Driving Wheels.

Cylinders. Dia. x stroke	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44
8 x 12	29.5	28.4	27.4	26.5	25.6	24.8	24.0	23.3	22.6	21.8	21.3	20.8	20.2	19.7	19.2	18.7	18.3		
8 x 14	34.4	33.2	32.0	31.0	29.9	28.9	28.0	27.1	26.3	25.6	24.9	24.2	23.6	23.0	22.4	21.8	21.3	20.8	
9 x 12	37.4	36.0	34.7	33.5	32.4	31.4	30.4	29.5	28.6	27.8	27.0	26.3	25.6	24.9	24.3	23.7	23.1	22.6	22.1
9 x 14	43.6	42.0	40.3	39.1	37.8	36.6	35.4	34.4	33.4	32.4	31.5	30.6	29.8	29.1	28.3	27.7	27.0	26.4	25.8
9 x 16	49.8	48.0	46.3	44.7	43.2	41.8	40.5	39.3	38.1	37.0	36.0	35.0	34.1	33.2	32.4	31.6	30.9	30.1	29.4
10 x 14	53.8	51.8	50.0	48.3	46.7	45.2	43.7	42.4	41.2	40.0	38.9	37.8	36.8	35.9	35.0	34.1	33.3	32.6	31.8
10 x 16	61.5	59.2	57.1	55.2	53.3	51.6	50.0	48.5	47.1	45.7	44.4	43.2	42.1	41.0	40.0	39.0	38.1	37.2	36.4
10 x 18	69.2	66.6	64.3	62.1	60.0	58.1	56.2	54.5	52.9	51.4	50.0	48.6	47.4	46.1	45.0	43.9	42.9	41.9	40.9
11 x 14	65.1	62.7	60.5	58.4	56.5	54.6	52.9	51.3	49.8	48.4	47.0	45.8	44.6	43.4	42.3	41.3	40.3	39.4	38.5
11 x 16		71.7	69.1	66.8	64.5	62.5	60.5	58.7	56.9	55.3	53.8	52.3	50.9	49.6	48.4	47.2	46.1	45.0	44.0
11 x 18			77.8	75.1	72.6	70.3	68.1	66.0	64.1	62.2	60.5	58.9	57.3	55.8	54.4	53.1	51.9	50.6	49.5
12 x 16				79.5	76.8	74.3	72.0	69.8	67.8	65.8	64.0	62.3	60.6	59.1	57.6	56.2	54.9	53.6	52.4
12 x 18					86.4	83.6	81.0	78.5	76.2	74.0	72.0	70.0	68.2	66.5	64.8	63.2	61.7	60.3	58.9
12 x 20						92.9	90.0	87.3	84.7	82.3	80.0	77.8	75.8	73.8	72.0	70.2	68.6	67.0	65.4
13 x 16							84.5	81.9	79.5	77.2	75.1	73.1	71.2	69.3	67.6	66.0	64.4	62.9	61.4
13 x 18								92.2	89.5	86.9	84.5	82.2	80.0	78.0	76.0	74.2	72.4	70.7	69.1
13 x 20									99.4	96.6	93.9	91.4	88.9	86.7	84.5	82.4	80.5	78.6	76.8
14 x 18										100.8	98.0	95.4	92.8	90.5	88.2	86.0	81.0	82.1	80.2
14 x 20											108.9	105.9	103.2	100.5	98.0	95.6	93.3	91.2	89.1
14 x 22												116.5	113.5	110.6	107.8	105.2	102.8	100.3	98.0
15 x 18													106.6	103.9	101.2	98.8	96.4	94.2	92.0
15 x 20														115.4	112.5	109.7	107.1	104.6	102.3
15 x 22															123.7	120.7	117.9	115.1	112.5
16 x 18																112.4	109.7	107.2	104.7
16 x 20																	121.9	119.1	116.4
16 x 22																		131.0	128.0
17 x 22																			141.5

Cylinders. Dia. x stroke	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
8 x 12																			
8 x 14																			
9 x 12																			
9 x 14	25.2																		
9 x 16	28.8	28.2																	
10 x 14	31.1	30.4	29.8																
10 x 16	35.6	34.8	34.0	33.3															
10 x 18	40.0	39.1	38.3	37.5	36.7														
11 x 14	37.6	36.8	36.0	35.3	34.6	33.9													
11 x 16	43.0	42.1	41.2	40.3	39.5	38.7	38.0												
11 x 18	48.4	47.3	46.3	45.4	44.4	43.6	42.7	41.9											
12 x 16	51.2	50.0	49.0	48.0	47.0	46.1	45.1	44.3	43.5										
12 x 18	57.6	56.3	55.1	54.0	52.9	51.8	50.8	49.8	48.9	48.0									
12 x 20	64.0	62.6	61.3	60.0	58.8	57.6	56.5	55.4	54.3	53.3	52.4								
13 x 16	60.1	58.8	57.5	56.3	55.2	54.1	53.0	52.0	51.0	50.1	49.2	48.3							
13 x 18	67.6	66.1	64.7	63.4	62.1	60.8	59.6	58.5	57.4	56.3	55.3	54.3	53.3						
13 x 20	75.1	73.5	71.9	70.4	69.0	67.6	66.3	65.0	63.8	62.6	61.4	60.3	59.3	58.3					
14 x 18	78.4	76.7	75.1	73.5	72.0	70.6	69.2	67.8	66.6	65.3	64.1	63.0	61.9	60.8	59.8				
14 x 20	87.1	85.2	83.4	81.7	80.0	78.4	76.9	75.4	74.0	72.6	71.3	70.0	68.8	67.6	66.4	65.3			
14 x 22	95.8	93.7	91.8	89.8	88.0	86.2	84.6	82.9	81.4	79.8	78.4	77.0	75.6	74.3	73.1	71.9	70.7		
15 x 18	90.0	88.0	86.2	84.4	82.6	81.0	79.4	77.9	76.4	75.0	73.6	72.3	71.0	69.8	68.6	67.5	66.4	65.3	
15 x 20	100.0	97.8	95.7	93.7	91.8	90.0	88.2	86.5	84.9	83.3	81.8	80.4	78.9	77.6	76.3	75.0	73.8	72.6	71.4
15 x 22	110.0	107.6	105.3	103.1	101.0	99.0	97.1	95.2	93.4	91.7	90.0	88.4	86.8	85.3	83.9	82.5	81.1	79.8	78.6
16 x 18	102.4	100.2	98.0	96.0	94.0	92.2	90.3	88.6	86.9	85.3	83.8	82.3	80.8	79.4	78.1	76.8	75.5	74.3	73.1
16 x 20	113.8	111.3	108.9	106.7	104.5	102.4	100.4	98.5	96.6	94.8	93.1	91.4	89.8	88.3	86.8	85.3	83.9	82.6	81.3
16 x 22	125.2	122.4	119.8	117.3	114.9	112.6	110.4	108.3	106.3	101.3	102.4	100.6	98.8	97.1	95.5	93.9	92.3	90.8	89.4
17 x 22	141.3	138.2	135.3	132.5	129.8	127.2	124.7	122.3	120.0	117.7	115.6	113.5	111.5	109.6	107.8	106.0	104.2	102.5	100.9

TABLE NO. 2.—TRACTIVE POWER PER POUND OF MEAN EFFECTIVE PRESSURE.

Diameter of Driving Wheels.

Cylinders. Dia. x stroke	44	45	46	47	48	49	50	51	52	53	54	55	56
17 x 24	157.6	154.0	150.8	147.6	144.5	141.5	138.7	136.0	133.4	130.9	128.4	126.1	123.9
17 x 26	170.8	167.0	163.3	159.9	156.5	153.4	150.3	147.3	144.5	141.8	139.1	136.6	134.2
17 x 28	183.9	179.8	175.9	172.1	168.6	165.1	161.8	158.7	155.6	152.7	149.8	147.1	144.5
18 x 24	176.7	172.3	169.0	165.2	162.0	158.7	155.5	152.5	149.5	146.7	144.0	141.4	138.8
18 x 26	191.4	187.2	183.1	179.2	175.5	171.9	168.5	165.2	162.0	158.9	156.0	153.2	150.4
18 x 28	206.2	201.6	197.2	193.0	189.0	185.1	181.4	177.9	174.5	171.2	168.0	164.9	162.0
18 x 30	220.9	216.0	211.3	206.8	202.5	198.4	194.4	190.6	186.9	183.4	180.0	176.7	173.6
19 x 24	196.9	192.5	188.3	184.2	180.5	176.8	173.3	169.9	166.6	163.5	160.4	157.5	154.7
19 x 26	213.3	208.6	204.0	199.7	195.5	191.6	187.7	184.0	180.5	177.1	173.8	170.7	167.6
19 x 28	229.7	224.6	219.7	215.1	210.6	206.3	202.1	198.2	194.4	190.7	187.2	183.7	180.5
19 x 30	246.1	240.7	235.4	230.4	225.6	221.0	216.6	212.3	208.3	204.3	200.6	196.9	193.4
19 x 32	262.5	256.7	251.1	245.8	240.7	235.7	231.0	226.5	222.2	217.9	214.0	210.0	206.3
20 x 24					200.0	195.9	192.0	188.2	184.6	181.1	177.8	174.5	171.4
20 x 26					216.7	212.3	208.0	203.9	200.0	196.2	192.6	189.1	185.7
20 x 28									215.4	211.3	207.4	203.6	200.0
20 x 30											222.2	218.1	214.3
20 x 32													
21 x 24							211.7	207.5	203.5	199.7	196.0	192.4	189.0
21 x 26							229.3	224.8	220.5	216.3	212.3	208.5	204.7
21 x 28									237.5	233.0	228.7	224.5	220.5
21 x 30											245.0	240.5	236.3
21 x 32													
21 x 34													
22 x 26							251.7	246.7	242.0	237.4	233.0	228.8	224.7
22 x 28									260.6	255.7	250.9	246.4	242.0
22 x 30											268.9	264.0	259.3
23 x 30											293.9	288.5	283.4
23 x 32											313.5	307.8	302.3
23 x 34											333.1	327.0	321.2
24 x 30											320.0	314.2	308.6
24 x 32											341.3	335.1	329.1
24 x 34											362.7	356.1	349.7
25 x 32											370.4	363.6	357.1

Cylinders. Dia. x stroke	57	58	59	60	61	62	63	64	65	66	67	68	69	70
17 x 24	121.7	119.6	117.6	115.6	113.7	111.9	110.1	108.4	106.7	105.1	103.5	102.0	100.5	99.1
17 x 26	131.8	129.6	127.3	125.2	123.2	121.2	119.3	117.4	115.6	113.8	112.1	110.5	108.9	107.3
17 x 28	141.9	139.5	137.1	134.9	132.6	130.5	128.4	126.4	124.5	122.6	120.8	119.0	117.3	115.6
18 x 24	136.4	134.1	131.8	129.6	127.5	125.4	123.4	121.5	119.6	117.8	116.1	114.4	112.7	111.1
18 x 26	147.8	145.2	142.8	140.4	138.1	135.9	133.7	131.6	129.6	127.6	125.7	123.9	122.1	120.3
18 x 28	159.2	156.4	153.7	151.2	148.7	146.3	144.0	141.7	139.6	137.4	135.4	133.4	131.5	129.6
18 x 30	170.5	167.6	164.7	162.0	159.3	156.8	154.3	151.9	149.3	147.3	145.1	142.9	140.9	138.8
19 x 24	152.0	149.4	146.8	144.4	142.0	139.7	137.5	135.4	133.3	131.3	129.3	127.4	125.6	123.8
19 x 26	164.7	161.8	159.1	156.4	153.9	151.4	149.0	146.7	144.4	142.2	140.1	138.0	136.0	134.1
19 x 28	177.3	174.3	171.3	168.5	165.7	163.0	160.4	157.9	155.5	153.1	150.8	148.6	146.6	144.4
19 x 30	190.0	186.7	183.5	180.5	177.5	174.7	171.9	169.2	166.6	164.1	161.6	159.3	156.9	154.7
19 x 32	202.7	199.2	195.8	192.6	189.4	186.3	183.6	180.5	177.7	175.0	172.4	169.9	167.4	165.0
20 x 24	168.4	165.5	162.7	160.0	157.4	154.8	152.4	150.0	147.7	145.4	143.3	141.2	139.1	137.1
20 x 26	182.5	179.3	176.3	173.3	170.5	167.7	165.1	162.5	160.0	157.6	155.2	152.9	150.7	148.6
20 x 28	196.5	193.1	189.8	186.7	183.6	180.6	177.8	175.0	172.3	169.7	167.2	164.7	162.3	160.0
20 x 30	210.5	206.9	203.4	200.0	196.7	193.6	190.5	187.5	184.6	181.8	179.1	176.5	173.9	171.4
20 x 32	224.5	220.7	216.9	213.3	209.8	206.4	203.2	200.0	196.9	193.9	191.0	188.2	185.3	182.9
21 x 24	185.7	182.5	179.4	176.4	173.5	170.7	168.0	165.4	162.8	160.4	158.0	155.6	153.4	151.2
21 x 26	201.2	197.7	194.3	191.1	188.0	184.9	182.0	179.2	176.4	173.7	171.1	168.6	166.2	163.8
21 x 28	216.6	212.9	209.3	205.8	202.4	199.2	196.0	192.9	190.0	187.1	184.3	181.6	179.0	176.4
21 x 30	232.1	228.1	224.2	220.5	216.9	213.4	210.0	206.7	203.5	200.4	197.5	194.6	191.7	189.0
21 x 32	247.6	243.3	239.1	235.2	231.3	227.6	224.0	220.5	217.1	213.8	210.6	207.5	204.5	201.6
21 x 34	263.0	258.5	254.1	249.9	245.8	241.8	238.0	234.2	230.7	227.2	223.8	220.5	217.3	214.2
22 x 26	220.8	217.0	213.3	209.7	206.3	203.0	199.7	196.6	193.6	190.7	187.8	185.1	182.4	179.8
22 x 28	237.7	233.6	229.7	225.9	222.2	218.6	215.1	211.7	208.5	205.3	202.3	199.3	196.4	193.6
22 x 30	254.7	250.3	246.1	242.0	238.0	234.2	230.4	226.9	223.4	220.0	216.7	213.5	210.4	207.4
23 x 30	278.4	273.6	268.9	264.6	260.2	256.0	251.9	248.0	244.1	240.4	236.8	233.4	230.0	226.7
23 x 32	296.9	291.8	286.9	282.1	277.5	273.0	268.7	264.5	260.4	256.5	252.6	248.9	245.3	241.8
23 x 34	315.5	310.1	304.8	299.8	294.8	290.1	285.5	281.0	276.7	272.5	268.4	264.5	260.7	256.9
24 x 30	303.1	297.9	292.8	288.0	283.3	278.7	274.3	270.0	265.8	261.8	257.9	254.1	250.4	246.9
24 x 32	323.4	317.8	312.4	307.2	302.2	297.3	292.6	288.0	283.6	279.3	275.1	271.1	267.1	263.3
24 x 34	343.6	337.7	331.9	326.4	321.0	315.8	310.8	306.0	301.3	296.7	292.3	288.0	283.8	279.8
25 x 32	350.9	344.8	338.9	333.3	327.9	322.6	317.4	312.5	307.7	303.0	298.5	294.1	289.8	285.7

Cylinders. Dia. x stroke	71	72	73	74	75	76	77	78	79	80	81	82	83	84
17 x 24	97.7	96.3												
17 x 26	105.8	104.4	102.9											
17 x 28	114.0	112.4	110.8	109.3	107.9									
18 x 24	109.5	108.0	106.5	105.1	103.7									
18 x 26	118.6	117.0	115.4	113.8	112.3									
18 x 28	127.8	126.0	124.3	122.6	121.0									
18 x 30	136.9	135.0	133.1	131.3	129.6									
19 x 24	122.0	120.3	118.7	117.1	115.5	114.0	112.5	111.1	109.7	108.3	107.0	105.7	104.4	103.1
19 x 26	132.2	130.4	128.6	126.8	125.1	123.5	121.9	120.3	118.8	117.3	115.9	114.5	113.1	111.7
19 x 28	142.4	140.1	139.4	136.6	134.8	133.0	131.3	129.6	127.9	126.3	124.8	123.3	121.8	120.3
19 x 30	152.5	150.4	148.3	146.3	144.4	142.5	140.4	138.8	137.1	135.4	133.7	132.1	130.5	128.9
19 x 32	162.7	160.4	158.2	156.1	154.0	152.0	150.0	148.1	146.2	144.4	142.6	140.9	139.2	137.5
20 x 24	135.2	133.3	131.5	129.7	128.0	126.3	124.7	123.1	121.5	120.0	118.5	117.1	115.7	114.3
20 x 26	146.5	144.4	142.5	140.5	138.7	136.8	135.1	133.3	131.6	130.0	128.4	126.8	125.3	123.8
20 x 28	157.8	155.6	153.4	151.4	149.3	147.4	145.5	143.6	141.8	140.0	138.3	136.6	134.9	133.3
20 x 30	169.0	166.7	164.4	162.2	160.0	157.9	155.8	153.8	151.9	150.0	148.1	146.3	144.6	142.9
20 x 32	180.3	177.8	175.3	173.0	170.7	168.4	166.2	164.1	162.0	160.0	158.0	156.1	154.2	152.4
21 x 24	149.1	147.0	145.0	143.0	141.1	139.3	137.4	135.7	134.0	132.3	130.7	129.1	127.5	126.0
21 x 26	161.5	159.2	157.1	154.9	152.9	150.9	148.9	147.0	145.1	143.3	141.6	139.8	138.1	136.5
21 x 28	173.9	171.5	169.2	166.9	164.6	162.5	160.4	158.3	156.3	154.3	152.4	150.6	148.8	147.0
21 x 30	186.3	183.7	181.2	178.8	176.4	174.1	171.8	169.6	167.5	165.4	163.3	161.3	159.4	157.5
21 x 32	198.8	196.0	193.3	190.7	188.2	185.7	183.3	180.9	178.6	176.4	174.2	172.1	170.2	168.0
21 x 34	211.1	208.2	205.4	202.6	199.9	197.3	194.7	192.2	189.8	187.4	185.1	182.8	180.6	178.5
22 x 26	177.2	174.8	172.4											
22 x 28	190.9	188.2	185.6											
22 x 30	204.5	201.7	198.9											
23 x 30	223.5	220.4	217.4											
23 x 32	238.4	235.1	231.9											
23 x 34	253.3	249.8	246.4											
24 x 30	243.4	240.0	236.7											
24 x 32	259.6	256.0	252.5											
24 x 34	275.8	272.0	268.3											
25 x 32	281.6	277.7	273.9											

slipping, varies according to the condition of the rail, whether the surface is wet or dry, covered with snow or ice, sanded or clean. Considerable discrepancy exists in the figures given by the different authorities as to the exact relation between the adhesion on the rail and the weight on the wheels.

In a paper entitled "The Effect of Brakes upon Railway Trains," read by Captain Galton before the Institution of Mechanical Engineers, this authority says:

"On dry rails it was found that the co-efficient of adhesion of the wheels was generally over 0.20. In some cases it rose to 0.25 or even higher. On wet or greasy rails without sand, it fell as low as 0.15 in an experiment, but averaged about 0.18. With the use of sand on wet rails it was above 0.20 at all times; and when the sand was applied at the moment of starting so that the wind of the rotating wheels did not blow it away, it rose up to 0.35, and even above 0.40.

These experiments seem to be the most reliable that have been published. They agree with the conditions noted in running locomotives of various ratios of adhesion to weight on drivers. For all practical purposes the question may be thus summed up: The adhesion should not be assumed to be more than one-fourth of the weight on the driving wheels, and for

TABLE No. 3.

Boiler Pressure.	Percentages of Boiler Pressure.					
	83	84	85	86	87	88
140	116.20	117.60	119 00	120.40	121.80	123.20
145	120.35	121.80	123.25	124.70	126.15	127.60
150	124.50	126.00	127.50	129.00	130.50	132.00
155	128.65	130.20	131.75	133.30	134.85	136.40
160	132.80	134.40	136.00	137.60	139.20	140.80
165	136.95	138.60	140.25	141.90	143.55	145.20
170	141.10	142.80	144.50	146.20	147.90	149.60
175	145.25	147.00	148.75	150.50	152.25	154.00
180	149.40	151.20	153.00	154.80	156.60	158.40
185	153.55	155.40	157.25	159.10	160 95	162.80
190	157.70	159.60	161.50	164.40	165.30	167.20
195	161.85	163.80	165.75	168.70	169.65	171.60
200	166.00	168.00	170.00	172.00	174.00	176.00
205	170.15	172.20	174.25	176.30	178.35	180.40
210	174.30	176.40	178.50	180.60	182.70	184.80
215	178.45	180.60	182.75	184 90	187.05	189.20
220	182.60	184.80	187.00	189.20	191.40	173.60
225	186 75	189.00	191.25	193.50	195.75	178.00
230	190.90	193.20	195.50	197 80	200.10	182.40
235	195.05	197.40	199.75	202.10	204.45	186.80
240	199.20	201.60	204.00	206.40	208.80	191.20
245	203 35	205.80	208.25	210.70	213.15	195.60
250	207.50	210.00	212.50	215.00	217.50	220.00

ordinary conditions, less than one-fifth of the weight on the driving wheels—or expressed differently, the co-efficient of adhesion for locomotives should not be considered as more than 0.25 or less than 0.20. The working range of proportions existing between the weight on drivers and tractive force may be summed up in these two figures, except in the conditions noted below. The limitation of one-fifth is often exceeded in passenger engines with very large wheels. In such cases the amount of tractive force is a secondary consideration to the necessity of having cylinders small enough and a boiler large enough, so that the amount of steam which the boiler can generate will be ample for the varying conditions of fast passenger service. No useful end seems to be gained, so far as the adhesion is concerned, by making the tractive force less than one-fifth of the weight on the drivers.

The co-efficient of adhesion existing between a revolving wheel and the rail is independent of the velocity. It is practically constant for all speeds, and only varies according to the character of the surfaces in contact. A very marked distinction must be made between the co-efficient of adhesion when the wheels are rolling and the co-efficient when the wheels commence to slip. In the first case the minute projections and depressions existing in the tire and rail may be said to fit into each other as the wheel rolls on the surface of the rail, interlocking, as it were, in a somewhat similar manner to a rack and pinion. After the wheel commences to slip, the resistance decreases rapidly as the speed increases in a similar manner to the well-known facts regarding the variation of friction existing between a brake shoe in contact with a wheel revolving at different velocities.

The very great decrease in friction when a wheel commences to slip is perhaps best shown by further reference to Captain Galton's experiments.

Although these co-efficients were obtained from slid steel tired wheels on steel rails, where the wheels were held from revolving by the brake shoes, and the stationary wheels were, therefore, drawn along the rails, yet it is thought the results are about the same as if the wheels were revolved in the same spot without moving along the rails. The following table gives approximately the co-efficient of friction derived from these experiments:

Dynamic Friction Between Wheel and Rail.

Approximate velocity.		Co-efficient of friction. Steet tire steel rail.
Feet per second.	Miles per hour.	
Just coming to rest...		.242
10	6.8	.088
20	13.6	.072
40	27.3	.070
50	34.1	.065
60	40.9	.057
70	47.7	.040
80	54.5	.038
88	60.0	.027

To obtain the best results in starting or when pulling the maximum load, it is evident that the tractive force should always be somewhat less than the minimum adhesion. At the moment of slipping the co-efficient of adhesion decreases to such an extent that it is necessary at once to shut the throttle until the wheels cease to slip. By using sand it is possible to get over short stretches of wet, slippery track, but the weight on the drivers should always be sufficient to "hold the engine to the track" under ordinary conditions of service.

A mistake in the engraving of Fig. 1 in Mr. Coles' article on "Mean Effective Pressure and Horse-Power," page 176 of the June issue of this paper, has just come to our notice. The words "Percentage of Increase of Speed," were wrongly added by the engraver to this diagram. They apply to Fig. 4, but not to Fig. 1.

DEFECTS IN PILOT AND TENDER COUPLERS.

Notwithstanding the number of different designs of couplers, a committee of the Southern and Southwestern Railway Club finds that "none of the manufacturers of automatic couplers for front ends of engines or back ends of tenders have as yet supplied the wants of the service for which they are intended."

A more flexible and elastic coupler is desired with limited vertical and lateral motion to prevent the excessive wear of knuckles and guardarms. This is particularly important where double heading is practiced, because of the constant vibration of the couplers. The semi-rigid type is criticised because of breakage of fastenings and drawbars as a result of the rigidity. The solid castings so often used at the rear ends of tenders are also too rigid. They frequently break in a way to make temporary repairs impossible and they cannot be used successfully on curves of more than 7 degrees.

This committee does not favor the drop or swing type of pilot coupler because when made strong enough for double heading they are unwieldy and heavy. The danger of cattle being knocked down by the bull-nose type of pilot coupler seems to the committee too remote to render this simple type objectionable.

In the opinion of this committee the most desirable form of coupler for double-heading would consist of the standard automatic coupler, with the buffer block and yoke as per M. C. B. drawing No. 11, for both pilot and tender, the details of attachment to tender to be such as the height of the engine and tender might require to maintain the standard height; the question of vertical and lateral motion to be allowed to be determined by the topography and curvature of the particular locality in which the device was to be used, but in general it is the opinion of the committee that the flexibility allowed as per M. C. B. recommended practice, drawing B, will be found sufficient.

* This is from a mean of three experiments only.

EXPRESS CAR FOR TRANSPORTATION OF HORSES.

New York Central & Hudson River Railroad.

The statistics of the larger express companies show a great increase during the last few years in the transportation of horses by express in passenger trains. This increase is undoubtedly stimulated if not entirely caused by improvements in methods of caring for horses on trains, and on a number of roads it has been found necessary to provide special equipment for this purpose. As owners of expensive horses are exceedingly critical of the accommodations the railroads have devoted considerable attention to the arrangement of these cars, and as they have been obliged to provide for this traffic in cars which are used for a large part of the time for other business the problem is rather an interesting one.

Through the courtesy of Mr. A. M. Waitt, Superintendent of Motive Power of the New York Central & Hudson River Railroad, we have received drawings showing the arrangement of ten new cars for the transportation of horses and other express business, which have just been built at the West Albany shops. The details of this design were worked out by Mr. F. M. Whyte, Mechanical Engineer of the road, under the direction of Mr. Waitt.

The officers of the American and National Express Companies expressed to the writer their entire approval of this construction. The easy riding qualities of the cars are especially appreciated. The car bodies are the same as the standard 60-ft. express cars of the road, except that at one end an 8-ft. door is provided, the door at the other end being 4 ft. 6 in. wide; the trucks are the standard 6-wheel type for passenger equipment, which accounts for the easy riding. The design throughout shows care to make a convenient arrangement of the movable partitions, the desired result being the best possible car for horses without causing inconvenience when used in other business.

Each of the cars will carry 16 horses. The arrangement of stalls is shown in Fig. 1. There is a section for four horses at each end of the car, and a double section for eight more at the center. Fig. 4 shows the form of the stall partitions, and it will be seen that cast-iron projections at the lower ends of the posts fit into holes in the floor to locate and secure the posts at the bottom. The upper ends are secured to partition supports of 2-in. pipe, extending across the car over the stalls and supported in iron fixtures. The posts are secured by pins, and when the car is wanted for other purposes the partitions are raised a little and moved along the floor to one side of the car, where they are out of the way. The pipe portions of the cross bars are then taken down and are carried upon the permanent portion shown at the left in Fig. 3, which is made in the form of a hook to receive and hold them. In this condition the car is unincumbered and unobstructed, except as regards the space occupied by the partitions, which are closed against the wall. There are no loose pins, keys or fittings, no bolts or nuts to be turned, and the whole arrangement is most convenient. At the center of the car gates are fitted, and the smaller one may be swung for the convenience of the attendants when the stalls opposite the small gate are not occupied. There is no padding whatever about the car, but great care has been taken to leave no sharp corners exposed. The detail of the partition shows that the horse's head comes far enough to the left, as shown in this view, to avoid hitting the cross bar, and this engraving also shows the partitions to be high enough to prevent the horses from reaching their heads over them. The large door is for carriages. The cars are provided with Pintsch gas and steam heat, and they are also ventilated,

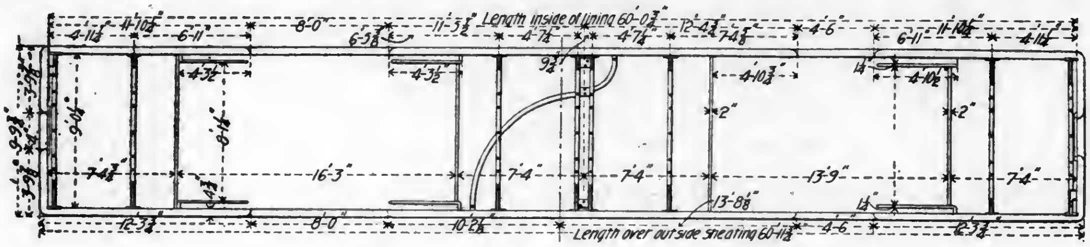


Fig. 1.—Floor Plan.

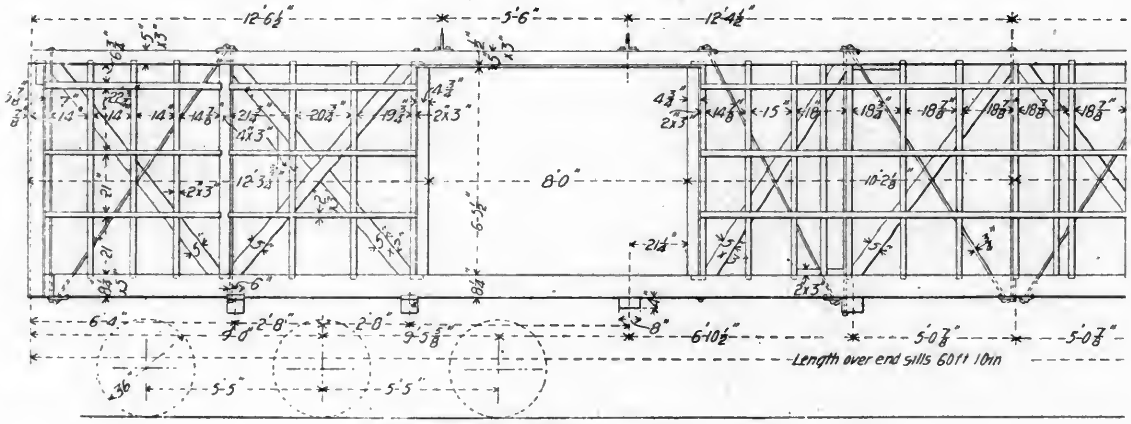


Fig. 2.—Framing of Car.

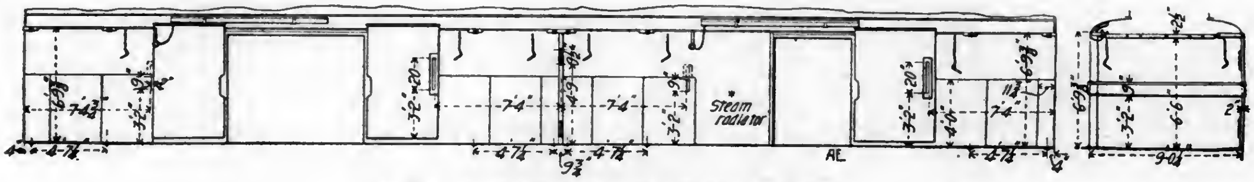


Fig. 3.—Side Elevation (Inside) and Section.

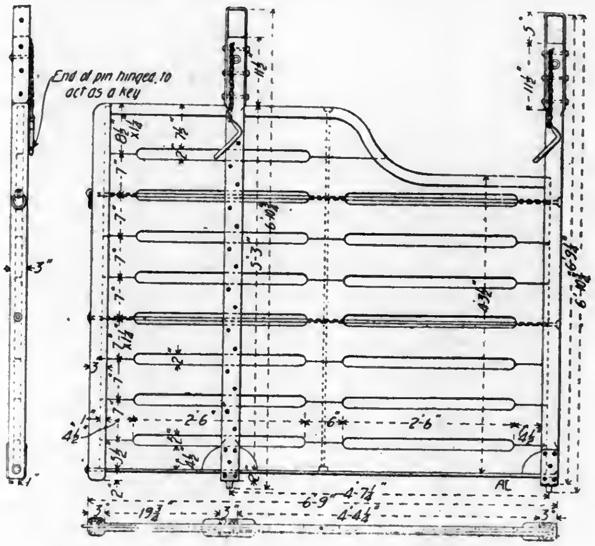


Fig. 4.—Details of Partition.

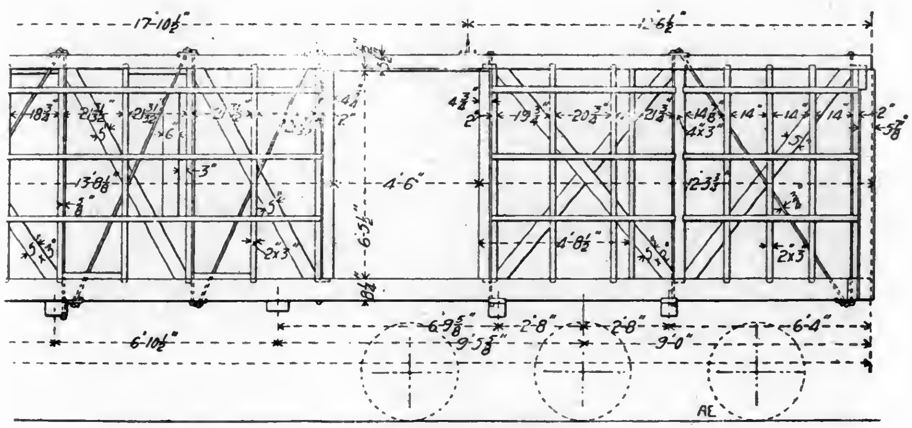


Fig. 2.—Framing of Car.

special care being taken to prevent drafts. A bridge for loading horses upon the cars is ingeniously arranged to be slung under the car on top of the truss rods. It is obvious that the partitions and cross bars may be kept at terminals, where they can be applied when necessary, but it is understood that they will be kept in the cars ready for use at any time.

Plush-covered seats, intricate fret and grillework, carved panels, carpets and boxed heating pipes are to be excluded from all future passenger equipment of the Big Four and Chesapeake & Ohio as a sanitary measure.

Reviewing the exhibits of locomotives at the Paris Exposition in the "Engineering Magazine," Mr. Charles Rous-Martin mentions the following points which seem to him most significant:

The enormous preponderance of the compound type of engine over the simple high-pressure type.

The comparative scarcity of eccentricities in design.

The immense increase in size and weight of locomotives since the last Exposition.

The specially huge size and power of certain Russian engines.

The almost universal employment of coupled wheels in express engines and the consequent all but complete disappearance of the single-driven type.

The large augmentation of heating surface and steam pressure.

TEMPERATURE AND FRICTION OF BRAKE SHOES.

An investigation of the effect of increase of temperature upon the friction of brake shoes which throws more light upon the subject than it has ever before received is recorded in a paper by Prof. R. A. Smart, of Purdue University, read last month before the Western Railway Club. The experiments appear to have an important bearing upon the prospective specifications of the M. C. B. Association for brake shoes. The paper is admirably arranged and thoroughly illustrated by aid of diagrams. The conclusions are summarized as follows:

So far as the writer is aware, no reliable information has been obtained heretofore on the effects of temperature, a fact which is easily explained by the difficulties attending such investigations. In fact, it is wellnigh impossible to carry out the experiments with a great degree of refinement or to arrive at other than general conclusions. This, however, has been done in the investigation under consideration, and the general conclusion reached is put forth with confidence as one which is accurate for all practical purposes.

The tests upon which the conclusion is based involve ranges of temperature of the shoe up to 1,500 degrees Fahr., speeds of from 40 to 60 miles per hour, and normal pressures of from 2,800 pounds to 6,840 pounds. They also involve continuous runs of about five miles in length and from five to ten minutes in duration. It is believed that the range of temperature mentioned is sufficiently high to embrace all but the most extreme conditions of service.

The conclusion drawn from these results confirms the one already stated; i. e., that within the limits of the tests the temperature of the rubbing surface does not affect the coefficient of friction.

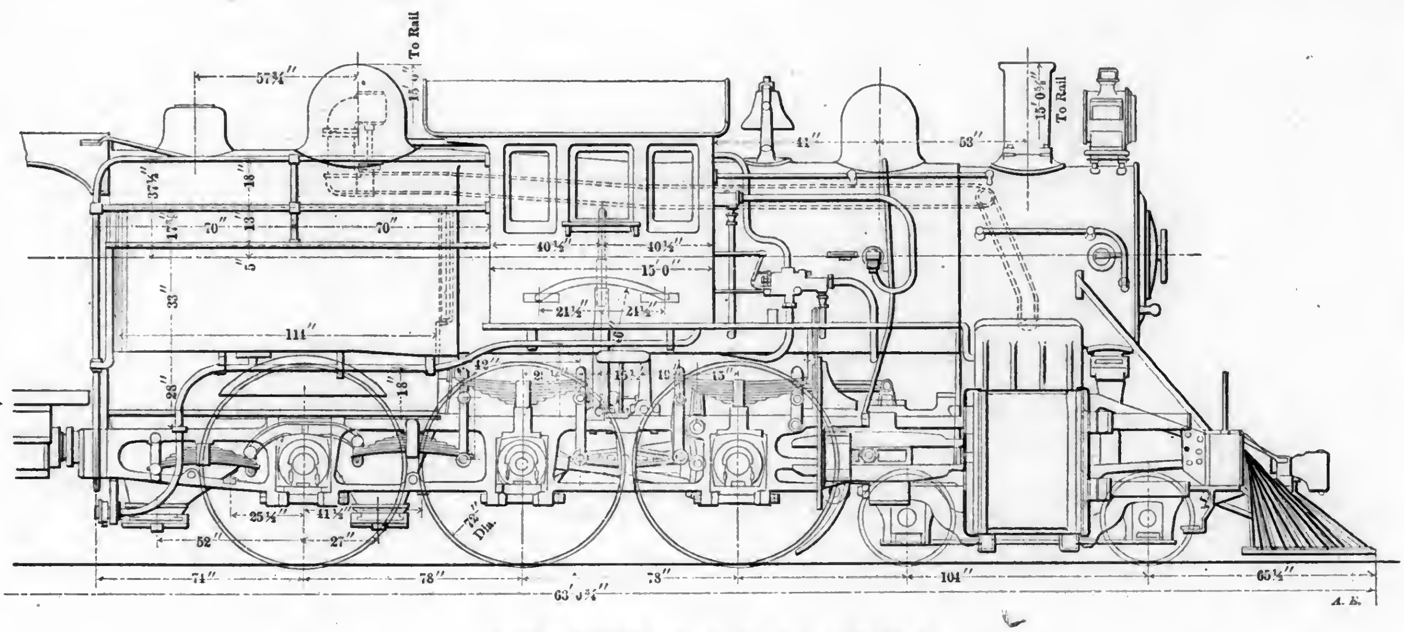
The coefficient of friction of brake shoes decreases with increase of pressure.

The coefficient of friction of brake shoes decreases with increase of speed, except from about ten to twenty miles per hour, between which speeds it increases slightly.

The coefficient of friction of cast-iron brake shoes is practically constant with variations in temperature of shoe and wheel within the limits of the experiments.

In view of the variable action of the majority of brake shoes while under test, it seems to the writer that it would be unwise to attempt to specify very narrow limits for the frictional qualities of shoes. A possible plan would be to choose some standard speed (or, possibly, two speeds) and prescribe a range of performance for different pressures within which the mean coefficient of friction of all shoes must come.

In order further to insure a sufficient degree of uniformity in the friction of each shoe during the length of the application, it should be specified that the coefficient of friction at a certain number of feet, after the application commenced, should not be less than such a per cent. of the mean coefficient of friction, and that the coefficient of friction a certain number of feet from the stop should not be more than a certain per cent. above the mean coefficient of friction, and should be less than a certain fixed limit. This arrangement would provide an element of elasticity which would cover the unavoidable variations in the results of tests, and at the same time would secure a degree of uniformity which would, in great measure, remedy existing evils.



Wide Fireboxes and Large Driving Wheels.

A New Design for Passenger Service—Lehigh Valley Railroad.

WIDE FIREBOXES AND LARGE DRIVING WHEELS.

The tendency toward the use of wide fireboxes for bituminous coal-burning engines is becoming pronounced, and many indications point to a general adoption of this practice. It is rather radical, but we have not yet heard a single unfavorable criticism of either the "Prairie" or "Northwestern" types as far as the size of the firebox is concerned, and we know of three entirely different designs of wide firebox engines for soft coal which are likely to appear during the approaching winter. We believe this to be a very important step in locomotive design, and it should be studied most carefully. Much has been said about having nearly approached the limits of weight and power (particularly of fast passenger engines), but it seems probable that the use of larger grate areas places the time for reaching the limits further into the future.

It is perfectly natural to turn to new wheel arrangements in the desire to use wide grates, and this tendency has and probably will continue to explain the appearance of a number of interesting locomotive designs. It seems to be an appropriate time to raise the question whether or not existing types, such as the eight-wheel, Atlantic, and 10-wheel arrangements will not suffice, and whether they will not all work out satisfactorily with wider grates. As to the Atlantic type there is no question but it would be well to try the other two-wheel arrangements with the large grates.

This suggestion involves the difficulties of high boilers and shallow fireboxes, but since a large amount of passenger service is too heavy for anything less than a six-coupled engine it seems worth while to experiment in both of these directions. The necessity for deep fireboxes for soft coal is strongly urged by many designers, but the question whether the advantages of depth may not be obtained by shallow boxes made longer and fitted with bridge walls does not seem to be settled, and it may be found that large wheels and wide fireboxes can be combined without inconvenience or loss in combustion due to short flame-way in a vertical direction.

The recent ten-wheel designs for hard coal on the Delaware, Lackawanna & Western, the Central Railroad of New Jersey and the Lehigh Valley, illustrated in our September number and in the present issue, are commended to the attention of those who are designing wide firebox passenger engines for soft coal burning. In the case of the Lehigh Valley 72-in. driving wheels are placed under a firebox 7 ft. 6 ins. wide. Mr. F. F. Gaines, Mechanical Engineer of this road, expresses his opinion on this subject in a recent communication as follows:

To the Editor:

In reading your article on page 92 of the September issue, "What is the Ideal Fast Passenger Engine?" it occurs to me that a 10-wheel type of engine with a wide firebox and an 84-in. driver is not altogether out of the question. I enclose you blue prints [Two of which are reproduced—Editor] showing the side elevation and the cross-sections and elevations of the boiler for a 10-wheel engine having 72-in. driving wheels and a firebox 7 ft. 6 ins. wide.

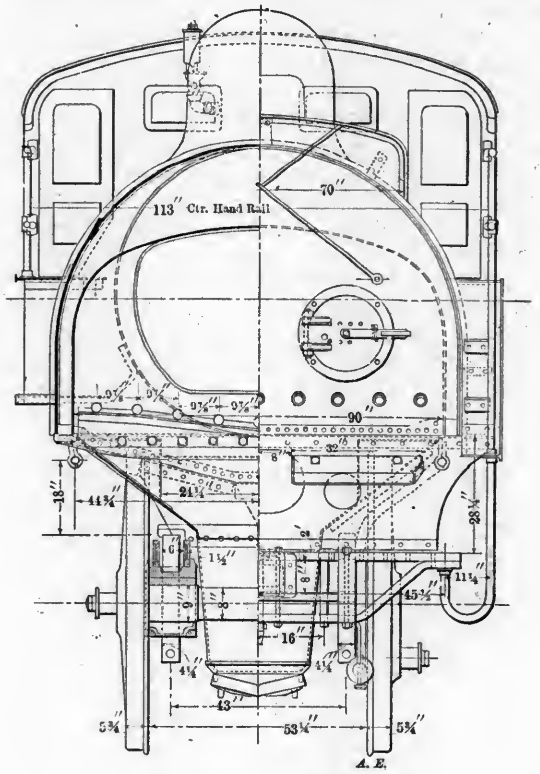
The drawings in question are for 10-wheel engines that are to be built in the near future for this road, and are to be used in heavy passenger service between Easton and Wilkes-Barre; they are intended to handle our heavy through trains between these points without the aid of a helper, where now we have to have a helper from Mauch Chunk to Wilkes-Barre.

The engines, as you will observe, are four-cylinder compounds having cylinders 17 and 28 by 26 ins.; the boiler is 64 ins. in diameter, of the wide firebox type, to carry 200 lbs. of steam; the grate area is 71.25 sq. ft.; heating surface of tubes, 2,536.59 sq. ft.; heating surface of the firebox, 171.71 sq. ft.; total, 2,708.3 sq. ft. The drivers are 72 ins. in diameter over tires; main journal, 10 by 12 ins.; front and back journal, 9 by 12 ins.; and engine truck journal, 6 by 12 in. The weight on drivers is 135,000 lbs., and the weight on the truck 45,000 lbs.

Owing to the limiting weight on drivers, in order that the boiler as shown might be used, it was necessary to figure very closely on the weights of the remaining parts, and with this end in view, cast steel has been largely used. The frames, driving wheel centers, equalizers, guides, grate bearer, rockers and driving boxes all being steel castings, phosphor bronze shoes and wedges are used in connection with the steel driving boxes.

The center of the boiler above the rail is 110 ins. In the September issue of your paper the D., L. & W. engine shown gives this distance as 114 ins. By taking the engine in question, and raising the boiler 4 ins. higher we could increase the driving wheels in diameter the same amount, which would then give us driving wheels 76 ins. in diameter.

By inspection of the boiler you will readily see that by either using a combustion chamber and brick wall, or by using a brick arch of the general type used in soft coal engines, we would be able to raise our grates fully 8 ins. higher, and



Section Through Firebox.

accordingly increase our driving wheels the same amount, which would then give us an 84-in. driving wheel. I do not consider the problem at all impossible, but practical, if the circumstances demand it, although it involves the use of either the combustion chamber or brick arch to attain the end in view, either of which, in my estimation, should not be used, unless the necessity is very great for the large diameter of driving wheel. An engine with drivers 76 ins. in diameter, which can be obtained in the 10-wheel type without going to the brick arch or combustion chamber, will haul a heavy train at a sufficiently high speed for all practical purposes, if this type of engine is desirable.

I think, however, in comparing the Atlantic and 10-wheel types of engine, some of the principal advantages of the Atlantic type have been overlooked entirely; with the Atlantic type sufficient tractive power can be obtained on two pairs of drivers to haul any reasonable weight of train, as only in starting will the maximum adhesion forces be brought into play, and that only for a few moments—by the use of sand sufficient adhesion can be obtained to start the heaviest trains—and when once started the tractive power rapidly drops down, due to working the engine at shorter cut-offs, so that the relation between cylinder tractive power and adhesion is well within the limits of good design.

I might say further, in regard to the Atlantic type, that with engines on heavy fast-passenger trains, the limiting factor, as far as power is concerned, is the boiler, and that in nine cases out of ten the actual tractive power is not a factor. The problem then presents itself of providing a boiler of sufficient size to provide steam for heavy fast runs; if such a boiler could be carried safely on two pairs of driving wheels, it would undoubtedly make the ideal engine, but experience has shown that it cannot be so carried, consequently the question resolves itself into a choice of the use of one of two designs, either the 10-wheeler or the Atlantic type. For exceedingly heavy trains, where the actual tractive power may be a factor, then of course it requires the 10-wheel type, but where it is not so much a question of tractive power as it is the free supply of steam at a high pressure in large quantities, the problem is much better solved, for the reasons already given, by the use of the Atlantic type.

The foregoing being true, the advantages of the Atlantic type are incontestable in that the rod connections are fewer and the rigidity of the engine is less; consequently the cost of repairs and liability of failure are both greatly reduced. Both of these items being of enough importance in my estimation to consider the Atlantic type of engine for a good many years to come as the best type for fast passenger service.

F. F. GAINES,
Mechanical Engineer, Lehigh Valley Railroad.

HOT JOURNALS.

From the Standpoint of Oil Pressures Between Bearing Surfaces.

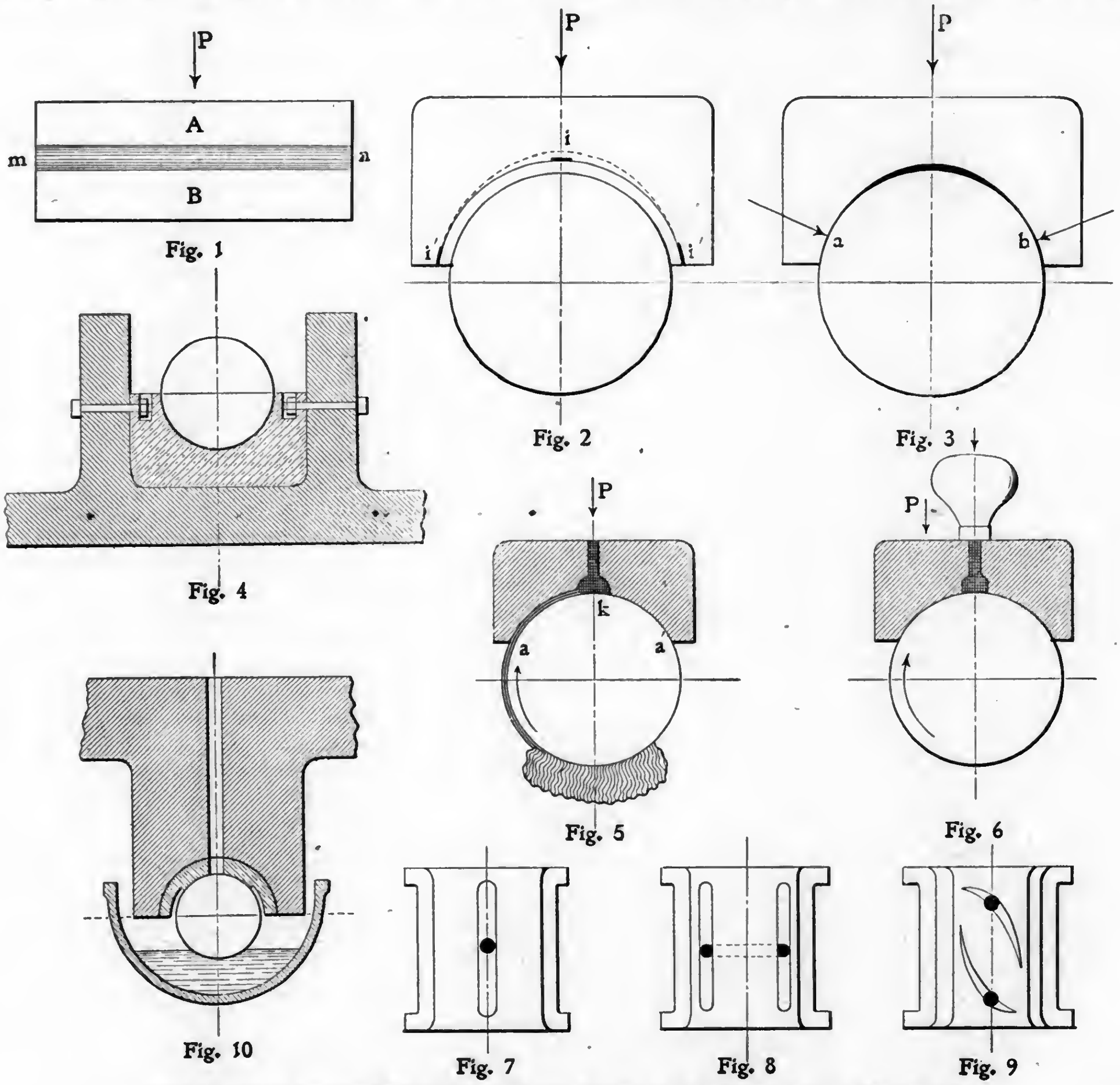
While it is difficult to say anything really new in regard to lubrication of journals it is clear that one phase of the subject is comparatively little understood, although there are evidences of the appreciation of difficulties in connection with it. The proper method of getting oil to the journals is referred to. It has long been understood that the pressure is greatest near the top of the bearing of railroad axles, and doubtless a great deal of the difficulty with hot boxes may be overcome when this fact is appreciated in its relation to the proper method of getting oil to the bearing surfaces.. It seems clear that locomotive driving journals need a little different treatment from that which they have usually received. Recently a review of the subject of hot bearings by Mr. Josef Grossmann, Inspector of the Northwestern Railroad of Austria, appeared in an Austrian publication* for a translation of which we are indebted to Mr. A. Christianson. This review is commended to our readers because Mr. Grossmann discusses a subject of special interest in its application to driving journal lubrication.

The question is to design bearings so as to bring the lubricating oil between the journal and the bearing and prevent it from working out. The chief cause of hot bearings is a deficiency of lubrication. Fig. 1 represents two bodies between which a layer of lubricating oil, m n, is drawn to an enlarged scale. The lubricant may be imagined to take the form of a series of a parallel oil layers, of which those nearest the metallic surfaces are held by a strong capillary force, drawing the oil into the pores of the metal. The oil layers between these furnish material upon the sliding process is carried out and the resistance of the oil layers against the motion of the two bodies constitutes the frictional resistance. Petroff has demonstrated that the conduct of the different oil layers by the sliding movement of two solid bodies is similar to the action of different liquids in a Poiseuilleshe's tube; that is, as soon as sliding begins the middle layers, which move easiest, have the highest velocity and the velocities decrease until the outside layers are reached and these being in contact with the sliding surfaces do not move at all with reference to those surfaces. It is necessary to insure the presence of the middle layers in order to avoid a retardation of motion and consequent friction. On the application of pressure to a bearing some of the middle layers will be forced out and the outside layers will come closer together, which necessitates the replacement of the middle layers with new oil. If this is not done the bearing surfaces will come closer and closer together until the danger of a hot bearing is reached and finally even the outside layers may be scraped off, giving direct contact between the surfaces, which is sure to cause trouble.

The load per square inch in Austrian railroad practice varies between 450 and 750 lbs., increasing at times to 1,185 lbs.; for tenders it is sometimes as high as 1,575 lbs. It is apparent that the oiling process in a great majority of railroad bearings take place under unfavorable conditions. A journal and bearing with the oil layer drawn to an enlarged scale is shown in Fig. 2. It is clear that each part of the bearing transmits load to the journal in proportion to its projection upon the journal and that the major part of the transfer is at the crown, where the greatest wear will occur. If the oil layer is taken away and the bearing placed directly upon the journal the bearing will transfer the load only through two narrow surfaces, Fig. 3. But if the bearing is not exceedingly strong it will spring and cramp the journal. If strong enough the greatest pressure will be at a b. When oil is brought to the bearing surface at the place where there is no load it may not be able to get in between the bearing surfaces, the pressure on the sides of the journal may be great enough to prevent the entrance of oil,

*Zeitschrift des Oesterr. Ingenieur.

which is at once sufficient cause for heating. It will be understood that the space between the journal and the bearing in a radial direction will be very small at most, merely the thickness of the oil. The cramping of bearings was first brought to the author's attention through Mr. Woodbury's paper before the American Society of Mechanical Engineers in 1885. In 1884 Herr Helmholz of Hanover called attention to the fact that the journal bearing of a roll after running hot had contracted so much toward the journal that a piece of tin could be passed between the journal bearing and the frame jaw in which it fitted closely before the heating. In his opinion the closing up on the journal was the cause for hot running and to remedy this the bearing of Fig. 4 was used in which bolts were employed to prevent the gripping of the journal. The author's method for overcoming this difficulty will be referred to later. His idea is shown in Fig. 10. It is not unlike the method of providing clearance on trucks and driving brasses on some American roads.



Hot Journals from the Standpoint of Oil Pressures Between Bearing Surfaces.

The location of the oil cavities and leaders has much to do with hot bearings. A distribution of the oil is very unsatisfactory in the usual method, because the oil leaders are generally located in the area of greatest load. The grooves soon wear to sharp edges by which the oil is scraped from the bearing surface and forced up through the oil hole if this is located at the top of the bearing. If the oiling is done from below by a swab or packing, Fig. 5, and the bearing is made of such shape as to avoid the closing in, at least the front half will be oiled. The other half will run more or less dry, because the lubricating oil will be scraped off by the edge, k. But if the oiling is done from the top, as in Fig. 6, no oil can get to the bearing surfaces at all. [The fact that oil does occasionally get to such bearings is undoubtedly due to the end motion of the journals, and probably to this alone.—Editor.]

The action of the oil in oil holes at the top of bearings loaded on top is discussed in the proceedings of the Institution of Mechanical Engineers (England) for 1883, describing exhaustive tests of the frictional resistance of journal bearings lubricated in different ways.

The fact is here communicated that in spite of oil leaders and the presence of sufficient oil, not one drop got in between the bearing surfaces, where it was expected to go. The tests employed bearings as shown in Figs. 7, 8 and 9, also different oil cups were used. Hot running always took place with a journal having an oil cavity arranged as shown in Fig. 7, even with a load of 105 lbs. per square inch, but when the load was removed for only a moment some oil got in between the bearing surfaces to be again forced out upon the application of the load and the oil raised immediately to its former height in the oil cup. Even the rounding off of the edges of the oil cavity did not suffice, and the test proved that no oil could get between the bearing surfaces under these conditions.

With the bearing of Fig. 8, oiling took place up to a load of 400 lbs. per square inch when heating commenced. The bearing shown in Fig. 9 was then tried, the oil leaders being the same as used in British locomotive practice, but this journal also refused to take oil, even when the oil column was in-

creased to a height of 10 ins. This bearing ran hot with a load of 200 lbs. per square inch. After repeated tests it was found that nothing would suffice but to oil the journal from below.

The clamping action of the bearing and the behavior of the oil leaders led Mr. Grossmann to recommend a bearing with a

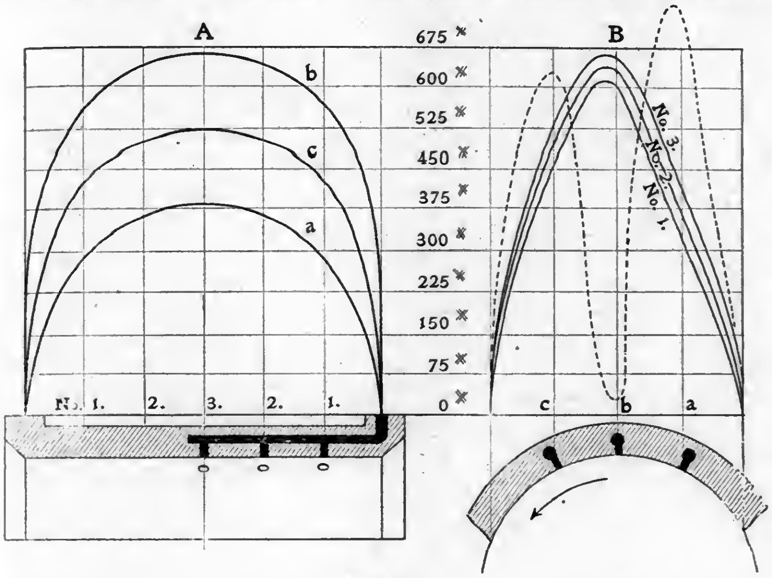


Fig. 11

very narrow bearing area, which did not sufficiently surround the journal to permit of closing in upon it. The oil grooves were left out entirely and the oil applied to the unloaded part of the journal by dipping into an oil bath or coming into contact with oily waste. Another form of the bearing suggested is shown in Figs. 12 and 13, in which it is exhibited in a form adapted for oiling from the top. Several holes are drilled through the crown of the bearing, but these are not for the passage of oil downward to the journal. They act to take oil up from the journal to the top of the bearing, from which it runs down through the grooves upon the outside of the bearing and reaches the journal where it has no load.

The phenomenon of oil driven upward from the bearing as in this case is not new. It is due to the pressure of the oil layers and the oil can only be removed by a large force. The resistance of the oil layers to the load causes the pressure,

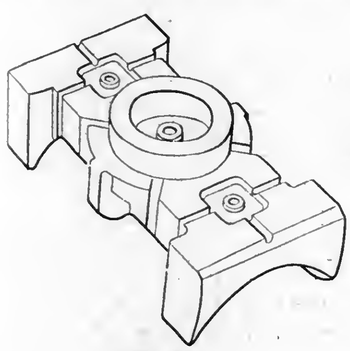


Fig. 12

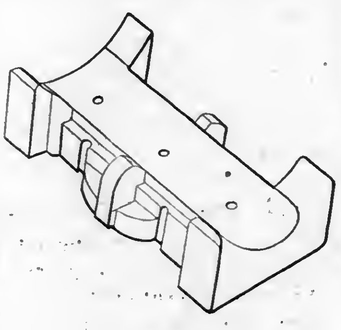


Fig. 13

which is proportional to the load. The London tests referred to included the measure of these pressures with the results given in the diagrams. The tests were made with an ordinary railroad car axle, the journal of which was arranged as in Fig. 10, with an oil hole drilled through the center of the bearing. In the first test the oil hole was not used, the oiling being done from below by an oil bath, and it was observed that the oil raised in the oil hole above, and upon the application of a gauge a pressure of 200 lbs. per square inch was discovered with a load of only 100 lbs. per square inch of the horizontal projection of the journal. The conclusion was that the pressure of oil between the journal and the bearing was a maximum at a line near the center of the bearing, decreasing to zero at the ends and lower edges and the pressures were systematically measured.

This was done with a 4 by 6 in. journal and a bearing having three small holes drilled from the outside face to the center lengthwise of the bearing. Gauges were connected to these by copper pipes and the pressures were taken by means of holes bored through the bearing into these longitudinal holes, so that the gauge was put into communication with the oil layer at different points, as in Fig. 11. The observations were taken separately and the holes carefully closed up after they were used.

The bearing carried a total load of 7,980 lbs., the journal made 100 revolutions per minute, the temperature was 90 degrees and the oiling was done by an oil bath from below. The observed pressures registered as follows:

In cross section	a	b	c
No. 1	326	585	452
No. 2	373	647	510
No. 3	389	658	526

Fig. 11A shows the pressure in the longitudinal direction, whereas Fig. 11B shows the pressure in the cross-section Nos. 1, 2 and 3. From the plotted curves the pressure in the six planes is shown. The pressure in the crown of curve b is larger than that of the curves a and c on either side. The total load figured from these curves was 7,959 lbs., which is a difference of 21 lbs. from the actual load.

An increase or decrease in the load caused a corresponding change in the pressure of the oil layer, but the pressure did not seem to be affected by a change of speed from 150 to 200 revolutions per minute. The bearing used in this test was perfectly smooth; that is, without oil cavities or leaders. With an oil cavity at the center the highest curve will fall out entirely, because of the presence of the oil cavity, which accounts for the falling off in the center of the curve indicated by the dotted line in Fig. 11B at the crown of the bearing, where otherwise the highest pressure would occur. It is obvious that the oil layer is considerably affected by the scraping action of the edge of the oil cavity and the unfavorable condition of this arrangement of bearing is clearly demonstrated.

The journal bearing recommended by the author of this paper employs a narrow bearing surface, which is free from oil cavities and oil leaders. It utilizes the pressure of the oil layers to force small quantities of oil to the back of the bearing, from which it runs through grooves to the journal below the brass, thus providing a circulation of oil. The three narrow lugs on each side of the bearing are to prevent it from being thrown out of place with the application of the brake. These bearings have been in use for three years in Austria with favorable results.

[The report of the Committee on Journal Bearings, Cylinder Details and Lubrication before the Master Mechanics' Association last June, of which Mr. W. C. Dallas was Chairman, records interesting experiments in the direction of omitting the top oiling of driving boxes.—Editor.]

The Lake Shore & Michigan Southern Railway gave an order to the Brooks Locomotive Works early in July for two large passenger engines with wide fireboxes. In many details the engines will be the same as the 10-wheel passenger engines now running on that road. A 2-wheel truck will, however, be substituted for the 4-wheel leading truck, and there will be a 2-wheel radial truck under the firebox, making the engine similar to the Prairie type. The engines will have three pairs of 80-in. drivers, 20 x 28-in. cylinders, 49 sq. ft. of grate and about 3,250 sq. ft. of heating surface, and the boilers will carry 200 lbs. pressure. Total weight of engine is estimated at 174,000 lbs., of which 128,000 lbs. will be on the drivers. The engines will be delivered early in December.

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Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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The trial of locomotives on roads other than those for which they are built is to be commended. It is important, however, that the trials should be made in the right spirit and with a view of learning facts rather than upholding one's own designs. The recent comparison of the new "Northwestern Type" locomotive with two standard engines on the New York Central, referred to elsewhere in this issue, is a unique case through which valuable information was obtained. The broad and liberal view of the idea taken by Mr. Waitt in permitting the publication of the results is particularly pleasing in view of the fact that the new design appeared to advantage beside his own. Such a comparison is as valuable as it is unusual.

Several promising improvements have recently been made in driving boxes with particular reference to methods of lubrication, and as the increasing weights and consequently increasing sizes of journals make this an exceedingly important subject, we have secured drawings showing some of them, and they will be published in future issues. Elsewhere in this issue is a review of a paper on the subject of lubrication to which the attention of motive power officers is earnestly invited. It seems to have been sufficiently demonstrated that the usual method of oiling driving journals through holes in the crown of the brass is not the best practice, because the pressure of the oil in the bearing is greatest at the top. It seems clear that the reason why such journals are lubricated at all is to be found in the end play or longitudinal motion, due to the clearance in the boxes. We will endeavor to show how the oil may be brought to the bearings satisfactorily and the number of hot driving boxes reduced, if the trouble is not entirely overcome.

Cylinder bushings are quite commonly used in repair work. They are frequently applied when cylinders wear too large in diameter to correspond with the driving wheels and boilers but, as indicated by Mr. F. E. Seley, in another column, they seem to offer important advantages in new construction. Some roads, notably the Chicago & Northwestern and Chicago, Milwaukee & St. Paul, use bushings in new locomotives and from the start the cylinders are placed in condition favorable to satisfactory wear. The bushings are inexpensive, they are made of good wearing iron; the cylinders may then be made strong without reference to wearing qualities and we should think that this practice would greatly simplify the foundry problems and reduce the number of broken cylinders. In answer to recent inquiries Mr. Bush, of the Chicago, Milwaukee & St. Paul, and Mr. Barr, of the Baltimore & Ohio, speak in positive terms of the practice. Mr. Bush uses cylinder bushings generally and considers them very desirable from a standpoint of economy. He says: "We are able to provide a thoroughly satisfactory metal for the bushings and also avoid the necessity for renewing cylinders." Mr. Barr has had a long experience with bushings and believes that they, and also false valve seats, should be used in order to get the right kind of material in the body of the cylinder and valve seat which will give the best wearing surface. He says that this cannot be accomplished in any other way. The practice will probably extend.

The expression "experimental stage" is very often used in a sense which seems to us unfortunate. Recently the status of the compound locomotive and of the piston valve have been described by it and nothing could be further from the facts. These improvements are no longer experimental in their fundamentals, no matter what their imperfections may be. The good standing of the principles which they represent were established long ago and it is only in the details that there is anything tentative or experimental. Considerable impatience is justified when motive power men say that they are waiting for these things to be perfected before they take them up. Valuable time is lost in delay and hesitation to make use of improvements so well understood as these when the advantages are so great and so apparent. It seems strange that anyone who is in a position to take a hand in the development and adoption of these principles can refuse to do so. Has not every motive power officer a duty to his company in this?

Arrangements for dealing with repairs to locomotive trucks in many of the older shop plants seem to be capable of improvement. This work is often done in the general repair shop and at the front end of the pits upon which the engines are standing. It seems desirable to provide a part of the shop with facilities specially intended for truck repairs and transfer all trucks to that place when the engines are dismantled. There are at least three reasons for considering such a plan. The truck work may be done better and quicker with the proper facilities. The tools are kept in one place and the work brought to them by cheap labor and space in front of the engine is saved for other purposes. This idea is carried out very

nicely in the tender shop of the Chicago & Northwestern (American Engineer, April, 1900, page 109), and a similar plan has been in use for years in passenger car repair shops.

NOTES.

Purdue University entered upon a new school year on Wednesday, September 12th, with a larger number of students in attendance than ever before in its history. The enrollment of the freshman class was approaching close to three hundred on the second day, with many new students yet to be matriculated. The number of freshmen will reach three hundred and fifty, and the total enrollment for the year will exceed one thousand. It is significant that the increase in the attendance is very largely within the schools of engineering. Preparations have been made during the summer in anticipation of a large attendance. Laboratory equipment in many departments has been increased, and one-half of the large building hitherto known as the men's dormitory has been so remodeled as to supply a dozen excellent additional recitation rooms. Both the newcomers and the old are, therefore, being well cared for.

The pneumatic fire kindler is an important piece of apparatus in the roundhouse. It is simply a compressed-air oil burner of the simplest construction, but of a usefulness entirely out of proportion to its simplicity. It is used above the coal, and without any kindling material. Some of the results of tests conducted by the mechanical engineering department of the University of Illinois with this instrument may be of interest. The tests were made to determine the relative costs of kindling fires by wood and by crude petroleum, the latter being burned by means of a fire kindler. The boiler pressure raised in each case was the same; the time required to reach this pressure was one hour and ten minutes kindling by oil and one hour and 44 minutes kindling by wood. The total cost, which in each case includes cost of labor, coal and the kindling material, amounts to 34 cents for oil and 61 cents for wood, on a basis of oil at 2¼ cents per gallon, and coal 75 cents per ton—a gain in favor of the oil of about 45 per cent.—Edward C. Schmidt, St. Louis Railway Club.

AN EXCURSION TO THE AMERICAN TROSACHS.

A number of members of the New York Railroad Club were the recipients in early September of invitations, issued under the name of its Executive Committee, "To visit the picturesque and historic mountains and valleys of the Ramapo on Saturday, September 15th." The excursion was in reality given by Mr. W. W. Snow, the Chairman of the committee.

In response to his hospitality about fifty members met in the Erie Railroad station in Jersey City soon after nine o'clock on the date named, and were received by their host and conducted to a special car, which was attached to the express train. From there they were taken by railroad to Tuxedo Park, and, as the French say, they then "descended" and took carriages which were provided, and the guests were driven through the park and around its beautiful lake, and all enjoyed the ride in the shaded roads, through the charming glens and over the breeze-ladened hills of that picturesque region. To nearly all the visitors Tuxedo Park was a revelation. Some of them had, it is true, a vague idea that it was a reservation, perhaps at most, as large as Central Park, in which a few well-to-do people had built houses and made of them summer residences; but it was a surprise to find that the park contains more than 4,000 acres of land and water, whose picturesque beauty it would be hard to match anywhere. The ground is rolling, the hills aspiring to the dignity of mountains, all thickly wooded from the valleys to their crests. The roads have been skillfully laid out, and are maintained in excellent condition. The lake is a large, beautiful sheet of water, surrounded with hills between which it reposes in calm placidity, which is restful to look at. Interspersed all through the Park are comfortable and luxurious houses, occupied by numbers of the club or association which is its owner. Altogether it seems an ideal place for a summer residence in which rest and health await the sojourner.

There are two club houses, at one of which the visitors alighted, and were seated on the delightful veranda. Years ago there was an erratic visitor who was an occasional caller at the office of the American Engineer. At the end of one of his visits he inquired of the editor whether he ever "lubricated the amenities of civilized life?" It was his polite way of inviting a person "to take a drink." Now the latter expression is a vulgar one, and therefore the host on this occasion metaphorically invited his guests to indulge in the amenities of civilized life, which the genial band of railroad brethren did while the balmy September breezes fanned their brows, some of which looked as though refreshment both within and without was very grateful.

That the conduct of the party while in the Park was entirely decorous, was evidenced by the fact that a lady—a resident thereof—and who knew nothing of the excursionists, but saw them while they were there—but not while they were on the veranda—reported that she thought it was a band of clergymen.

From the Club House the drive was continued through the Park, and around the lake, via the south gate, and thence by carriage and railroad they visited the Sterling iron mines at Sterling Lake, which the "itinerary" of the excursion said is "the Lake Como of America." These mines have been worked ever since the Revolutionary War, and are entirely subterranean, extending below the bed of the lake. The ores are valuable as mixtures with other ores in the manufacture of some kinds of iron. The ruins of some ancient furnaces which were built some time during the last century, and were operated in Revolutionary days, were pointed out. Lunch was served in a beautiful groove overlooking the lake, and the amenities were again lubricated with ginger ale and—but that is another story.

From Sterling Lake, as the printed "itinerary" poetically expressed it, "through vale and over mountain" the excursionists were taken by rail and carriage to the beautiful home of the Hon. Abram S. Hewitt, which is in this vicinity. The party was received by him and his family with great courtesy, and after other "amenities" had received due attention were conducted over the grounds and shown many very interesting relics of Revolutionary days, which were described by Mr. Hewitt in a way that made the writer regret again—as he has many times before—that writing shorthand was not one of his accomplishments. All were delighted with the visit, and it recalled a popular essay with the title "How to Grow Old Gracefully," which was current twenty-five or thirty years ago. Knowing something of the past career of Mr. Hewitt, the visit suggested that as a prelude to "growing old gracefully," it is essential to live wisely, and that by doing the latter it may be possible when the autumn of life is reached to accept it as gracefully and as graciously as he does.

From his place Mr. Hewitt joined the excursionists, who were taken by carriage and railroad to the Glens of Greenwood Lake, the latter a beautiful sheet of water surrounded by picturesque hills. An excellent dinner was served there with "lubrication." The menu was a work of art, and appealed to the guests aesthetically and gastronomically. After the dinner there were a few short speeches, and much feeling of good-fellowship. From Greenwood Lake the party returned to New York by special train over the Greenwood Lake Railroad, and all united in spirit, if not vocally, in singing "For Snow is a jolly good fellow."

M. N. F.

PERSONALS.

Mr. George W. Seidel has been appointed Master Mechanic of the Lehigh Valley at Buffalo, N. Y., in place of Mr. L. I. Knapp, resigned.

Mr. C. A. Storm has been appointed Mechanical Engineer of the Illinois Central, with headquarters at Chicago, to succeed Mr. E. Grafstrom, resigned.

Mr. Richard H. Relf, Chief Clerk in the Engineering Department of the Northern Pacific, has been appointed Assistant Secretary in place of P. W. Corbett, deseased.

Mr. D. E. Davis has been appointed General Foreman of the Boston shops of the Boston & Maine, and will have entire charge of these shops, to succeed Mr. Hammett, promoted.

Mr. J. W. Marden, heretofore Superintendent of Rolling Stock of the Fitchburg, has been made Foreman of the Car Department of the Fitchburg Division of the Boston & Maine, with headquarters at Boston.

Mr. F. W. Cox, General Foreman of the Locomotive Department of the Chicago, Milwaukee & St. Paul at West Milwaukee, Wis., has resigned, to accept a position with the mechanical department of the Baltimore & Ohio at Baltimore, Md.

Mr. J. D. Murray has been appointed Chief Draftsman of the Car Department of the Delaware, Lackawanna & Western. Mr. Murray has heretofore been connected with the New York Central, and formerly with the Chicago & Northwestern.

Mr. W. F. Beardsley, Master Mechanic of the Northwest System of the Pennsylvania Lines, at Allegheny, Pa., has been transferred to a like position at Crestline, O., in place of Mr. J. D. Harris, who is transferred to Wellsville, O. The latter to succeed Mr. G. P. Sweeley, who is made Master Mechanic, in place of Mr. Beardsley, at Allegheny.

It is officially announced that Mr. P. M. Hammett, Division Master Mechanic of the Boston & Maine, has been appointed Assistant Superintendent of Motive Power of that road. Mr. Hammett was born in 1867. He graduated from Havard College in 1888, and from the Massachusetts Institute of Technology in 1890. He began his railroad service with the Pennsylvania as an apprentice in the shops at Altoona. In 1893 he was appointed General Foreman of the Wilmington shops of the Philadelphia, Wilmington & Baltimore, and three years later entered the service of the Boston & Maine as Division Master Mechanic.

Mr. Robert Rennie has been appointed Master Mechanic of the Pennsylvania Division of the Delaware & Hudson Company with headquarters at Carbondale, Pa., in place of Mr. W. R. Johnson, resigned. Mr. Rennie entered the employ of the Pennsylvania as a machinist in December, 1890, at the Meadow shops and was transferred to the Juniata shops at Altoona in the spring of 1893. While at these shops he worked his way into the Testing Department, where he remained until 1897, when he took charge of the Richmond Tramp Compound for the Richmond Locomotive Works. This position he left after two years to accept the position of General Foreman of the Lehigh Valley, at Easton, Pa.

Edwin M. Bushnell, General Manager of the U. S. Railway Supply Co., died at his home in Brooklyn, Monday, September 24, after an illness of only a week, and at the age of 39 years. The news of his death reaches us as the paper goes to press. He was probably best known in connection with the Bushnell Manufacturing Co., of Easton, Pa., in which he was associated with his father until about two years ago, when he came to New York and organized the U. S. Railway Supply Co. He was a genial, pleasant companion for those who met him in business and knew him slightly. To those who knew him better he was a warm and disinterested friend and to the few who understood him thoroughly his kindly and noble nature inspired the feeling that few men can bring out. He was popular and successful, and will be mourned by many high officials of the railroads as well as others.

TRAVELING ENGINEERS' ASSOCIATION.

At the recent meeting of this association in Cleveland the most important discussions were those on the handling of air-brake trains, the use of the steam engine indicator and smokeless firing.

It was considered advisable to use two applications of the brakes for passenger trains and one long application for freight. For breaking on "double headers" where the use of the air pumps and main reservoirs on both engines is desired it was recommended that the cut-out cock at the brake valve be closed and additional pipe connections made. The parting of freight trains was shown to be a serious matter, particularly when large capacity steel cars were mixed in with lighter cars in trains. The association believed the trouble to be due to weak draft rigging instead of improper handling of the brakes, as is often stated in reports.

The report on the steam engine indicator was noteworthy. It contains a great deal of information about indicator cards and will probably stimulate interest in the indicator, and we hope it will lead to more general use of the instrument.

Smokeless firing occupied a large share of attention. The only apparatus needed in order to secure satisfactory results was the ordinary fire-brick arch, but it was often neglected. A brick arch in good condition and light firing were considered all that was necessary. Good results were reported for the form of fire door used on the Southern Pacific. This door has a small opening for the coal and it is always kept open. The small size of the opening made it impossible to fire coal in large quantities. It was shown to be necessary for the higher officers of a road to co-operate in the matter of smoke prevention.

The committee on connections between injectors and locomotive tanks strongly recommended the substitution of large strainers which may be easily removed for the usual conical hose strainer. The holes should not be larger than ⅛ in. in diameter. Injector connections had not been enlarged to correspond with the increased size and power of locomotives, and larger pipes and hose connections were considered necessary. For Nos. 5, 6 and 7 injectors the hose should have an inside diameter of 2 in. For Nos. 8, 9 and 10 it should be 2½ in., and for all sizes larger than No. 10 it should be 3 in.

The meeting was well attended and the discussions were earnest. Mr. C. H. Hogan, of the New York Central, was elected President for the coming year. The next annual convention is to be held in Philadelphia.

Russell snow-plows and flangers of various styles are to be built this fall for the following railroad companies: Boston and Albany R. R., Central Railroad of New Jersey, Chicago, Milwaukee & St. Paul Ry., Delaware, Lackawanna & Western R. R., New York Central & Hudson River R. R., New York, Chicago & St. Louis R. R. and New York, Ontario & Western Ry.

The cast-steel body bolster illustrated on page 291 of our September number was credited to Mr. G. A. Akerlind, Chief Draftsman of the road, who has just informed us that it is the joint production of himself and Mr. J. T. Carroll, at the time assistant in the drawing office, now Mechanical Engineer of the "Nickel Plate."

HEAVY TWELVE-WHEEL FREIGHT LOCOMOTIVE—VAUCLAIN COMPOUND.

MINNEAPOLIS, ST. PAUL & SAULT STE. MARIE RAILWAY. BALDWIN LOCOMOTIVE WORKS, *Builders.*

Weights: Total of engine............207,210 lbs.; on drivers...........184,360 lbs.; total engine and tender.... ....327,210 lbs.
Wheel base: Driving........19 ft. 4 in.; total of engine........28 ft.; total of engine and tender ....57 ft. 4 in.
Cylinders: 17 and 28 x 32 in. Wheels: Driving,..... 55 in.; truck........... 30 in.; tender.... ......33 in.
Boiler: Diameter .. ..68 in.; boiler pressure........ 215 lbs.
Firebox: Length . ...132 in.; width.......... 41 in.; depth, front.... ....77 in.; depth, back............76 in.
Grate area ....37.5 sq. ft. Tubes: 344, 2 in.; 15 ft. 7 in. long.
Heating surface: Tubes ....2,791.8 sq. ft.; firebox............223.9 sq. ft.; total.... .. 3,015 sq. ft.
Tender: Eight-wheel; water capacity, 7,000 gals.; coal capacity............9 tons.

TWELVE-WHEEL COMPOUND FREIGHT LOCOMOTIVE.

Minneapolis, St. Paul & Sault Ste. Marie Railway.

Built by the Baldwin Locomotive Works.

Usually the heaviest freight locomotives are wanted for particular kinds of service, and it is customary to build them to certain definite requirements. The large Illinois Central 12-wheel engine illustrated in our October number last year, page 315, is understood to have been guaranteed to haul 2,000 tons of cars and load over a grade of 35 ft. per mile. The engine of the same type recently built for the Minneapolis, St. Paul & Sault Ste. Marie by the Baldwin Locomotive Works was guaranteed to take the same weight at six miles per hour over a compensated grade of 42 ft. per mile, and this condition was fully met; but the most interesting fact concerning it is the low fuel consumption, which is given in the following table:

Performance Engine 600. August 21, 22 and 26, 1900.

Date.	Distance.		Tonnage: Net.	Tonnage: Tare.	Tonnage: Total.	Cars: Loads.	Cars: Empties.	Ton miles.	Tons coal used.	Lbs. coal per 10,000 ton-miles.
Aug. 21... Ex East	111		1,205.9	790.7	1,996.6	58	0	221,622.6	11.1150	1,044
Aug. 22... Ex West	111	Max.	1,298.8	937.47	2,236.27	60	6	222,782.8	11.425	1,007
Aug. 26...	111		1,227.7	785.05	2,012.75	58	0	223,415.25	10.1450	960

Note.—There are 7 miles omitted on trip of Aug. 26, on account of doubling over a piece of track with a 68-ft. grade.

As this is an opportunity to compare a simple engine with a compound which is guaranteed to do somewhat more than the simple engine, some of the leading dimensions are brought into parallel columns. We do not know the official figures for the fuel consumption of the big Illinois Central engine, but it is rumored that it is not "light on coal." We should think that the advantages of compounding would appear most prominently in such service as this, where the design may be prepared for conditions which seem to be most favorable to this type. The comparison of these figures is to us exceedingly interesting:

	I. C.	"Soo."
Total weight	232,200	207,210
Weight on drivers....................	193,200	184,360
Size of drivers	57 in.	55 in.
Cylinders	23 x 30 in.	17 and 28 x 32 in.
Heating surface	3,500 sq. ft.	3,015 sq. ft.
Grate area	37.5 sq. ft.	37.5 sq. ft.
Steam pressure	210 lbs.	215 lbs.
Size of boiler	82 in.	68 in.
Tubes, number	424	344
Tubes, size	2 in.	2 in.
Tubes, length	14 ft. 7¾ in.	15 ft. 7 in.

The photograph and the following particulars concerning this design, which is a Vauclain compound, have been furnished by the builders:

General Dimensions.

Cylinders

Diameter (high pressure)...17 in.
Diameter (low pressure)...28 in.
Stroke ....32 in.
Valve .... Balanced piston

Boiler.

Diameter ....68 in.
Thickness of sheets ....11/16 and ¾ in.
Working pressure ....215 lbs.
Fuel .... Soft coal

Firebox.

Material .... Steel
Length .... 131 15/16 in.
Width ....41¼ in.
Depth ....Front, 77⅝ in.; back, 76 in.
Thickness of sheets.......................Sides, 5/16 in.; back, 5/16 in.; crown, ⅜ in.; tube, ½ in.

Tubes.

Number 344
Diameter .... 2 in.
Length ....15 ft. 7 in.

Heating Surface.

Firebox ....223.9 sq. ft.
Tubes ....2,791.8 sq. ft.
Total ....3,015.7 sq. ft
Grate area ....37.5 sq. ft.

Driving Wheels.

Diameter, outside ....55 in.
Diameter of center ....48 in.
Journals ....Main, 9½ by 12 in.; others, 8½ by 12 in.

Engine Truck Wheels

Diameter .... 30 in.
Journals ....6 in. by 10 in.

Wheel Base.

Driving ....19 ft. 4 in.
Rigid ....19 ft. 4 in.
Total engine ....28 ft. 0 in.
Total engine and tender...57 ft. 4 in.

Weight.

On drivers ....184,360 lbs.
On truck ....22,850 lbs.
Total engine ....207,210 lbs.

Tender.

Diameter of wheels...33 in.
Journals ....5½ in. by 10 in.
Tank capacity ....7,000 gals.; 9 tons of coal

BACK NUMBERS OF M. C. B. REPORTS.

Back volumes of the proceedings of the Master Car Builders' Association may be had from the Secretary, Mr. J. W. Taylor, except for the years 1873 to 1879, inclusive, and for the year 1891. The reports previous to 1895 were bound in paper and will be furnished at 75 cents per copy. Beginning with 1895 they were bound in cloth, for which the price is $1.50 per copy. The Secretary offers an opportunity for members and others to secure a large number of the back volumes.

CORRESPONDENCE.

THE MODERN ROUNDHOUSE—WHAT IT OUGHT TO BE.

To the Editor:—I have been much interested in the article, "The Modern Roundhouse—What It Ought to Be," which appeared in your August issue, page 245. In general, I think it an excellent article and one which if followed would mean a higher standard of efficiency for the locomotive, and it would increase the output of the repair shop.

How many of the smaller, overcrowded shops of even our large roads would prove amply large enough to care for one, two or even three more engines per month were the class of repairs known as roundhouse repairs faithfully attended to at the roundhouse? The poor roundhouse foreman must not be blamed for all, for how many roundhouses at important centers could we visit to-day and either find no tools or some which should have been in the scrap heap long ago, together with other conditions which are not only costly to maintain, but which are really a disgrace, and yet from these, good work and well-kept engines are expected.

It seems to me the same reason as put forth by Mr. Whyte in a short note in your September issue (and also expressed in the report) as to heading engines into the erecting shop holds true in roundhouse practice, but I do not agree with this committee that when engines back out they will be cleaner. This may be a minor point, but assuming that we have three adjacent pits with three clean engines (rather a bold assumption). The center one starts to back out; naturally the cylinder cocks are opened and the discharge from these as well as from the stack is kindly shared by the adjacent engines and from the moment the stack leaves the smoke jack overhead until outside the house the conditions are the same.

I think dirt floors in roundhouses where work is to be done should be replaced by some such material as suggested.

I hardly agree with the recommendation that all pipes should be overhead, one reason being that which the committee themselves put forth a little further on in the article, for the use of hot air—namely, to have it delivered from the side walls of each pit, where it will be "most effective in thawing out engines that have come into the house covered with snow and ice." Why should not the same reason and position (on the side walls of each pit) hold good for steam pipes? Heated air rises and overhead steam pipes, unless much larger than need be, otherwise will not heat the roundhouse as well as in the pits, and with the doors open a goodly share of the time the overhead pipes, unless well protected, which is not what you want for heating, are very apt to leak, due to the rapid changes in temperature in the surrounding air currents, and then whatever is below derives the benefit from this leakage. Certainly my experience has been that pipes with the proper pitch to care for condensation and properly attached to the walls of each pit will prove superior in service. The first cost is much less, which appeals in many cases to those in authority, and where spare engines are kept ready or considerable time elapses between runs the engines can be coupled up to this piping system and a saving made by so doing.

For the equipment I would include a good forge for use in repairing or straightening brake rods, etc.

There are two points not touched on at all in this report, one of which appeals to me as important, the number, location, height and equipment of the benches. Should they be along the outer wall at intervals or between the pits? Also engineer closets, what about them? I would also like to have the committee's opinion on the best material for smoke jacks or hoods.

I have in mind other suggestions, but would like to see a discussion started from the above, as that means finally all the points for a thoroughly equipped roundhouse.

G. E. MITCHELL, Mechanical Engineer.

New York, September 4, 1900.

In speaking of the relative cost of the present electric and the former steam power for the "Alley L" road of Chicago, Mr. Frank J. Sprague stated before the American Institute of Electrical Engineers that the saving in coal alone is $500 per day.

FLEXIBLE STAYBOLTS IN INDIA.

Effect on Life of Firebox Sheets.

To the Editor:

I observe in your excellent journal on page 382 of the number for December last an interesting paper on staybolt progress. I, however, decline to permit you to give Mr. F. W. Johnstone, of the Mexican Central Railway, the credit for the invention of the flexible stay therein attributed to him. It is possible that he has contributed his quota to bringing up the design to what it now is; but honor should be given to whom honor is due.

If you will refer to "The Engineer" (London), in one of its issues of November, 1879, you will find a most interesting paper on the subject, showing how this system was first invented

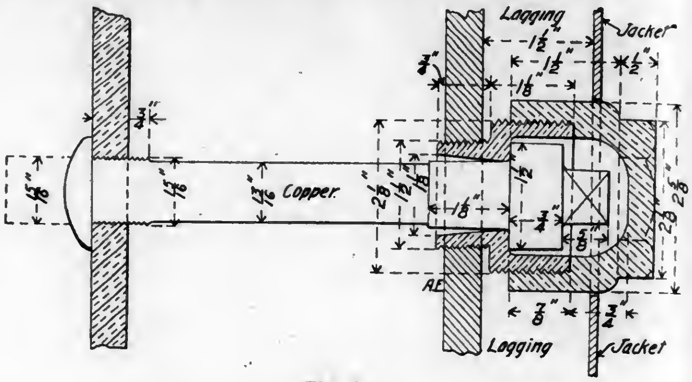


Fig. 1.

and put into practice by Mr. Wehrenfennig, the then Chief Engineer of Material and Traction of the North-Eastern Railway of Austria. I am not aware whether he be still in the land of the living.

Some time subsequent to 1882 the Wehrenfennig system of flexible staying was very much improved upon by the late Mr. W. Leach, the Foreman Boiler-maker of the Rajputana-Malwa Railway of India. He made and patented great im-

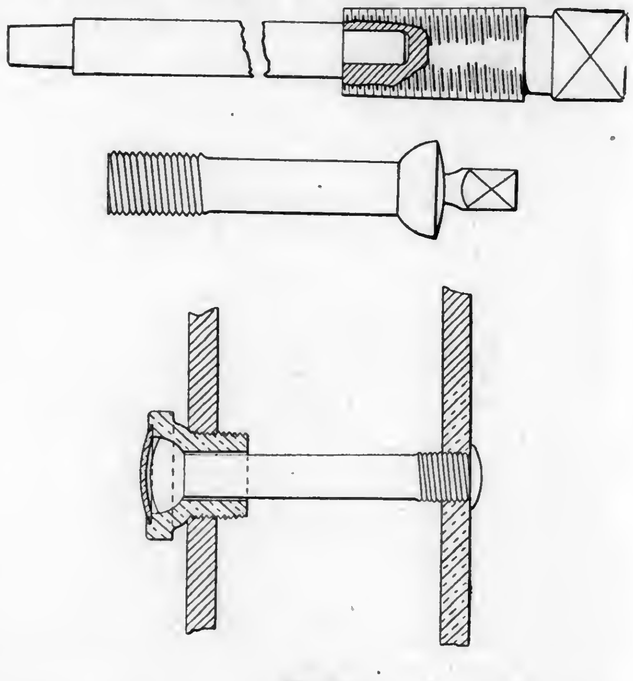


Fig. 2.

provements in the system, which has been applied on that railway to many hundreds of boilers with the greatest success and immense economical advantage. The water on that railway in some parts is so bad (being heavily charged with magnesium sulphate) that in years gone by I have known new engines with rigidly stayed fireboxes to have their tube plates entirely renewed in less than 12 months from the time they began to run. Since the Leach stay was adopted such disastrous failures are a thing of the past.

I applied Wehrenfennig's system to an old firebox of an en-

gine in India (Central Provinces) in 1882. The tube plate was good but the holes in it were distorted and oval. The bridges were intact but could not have lasted much longer without cracking. I did it as a severe test of the ease to be afforded to that tube plate by flexible staying. In 1894 I learned that that firebox was still running and no further repairs done to it; the tube plate being in just the same condition. The engine had in the interval been in the hands of strangers 2,000 miles away from me and there had been no jockeying or coddling of the tube plate.

In 1893 I fitted a couple of new fireboxes to boilers on the Burma Railways with the Leach stay. Since then they have run about 107,000 miles each without costing anything for repair to the staying or plates.

I enclose ferrotypes of both Wehrenfennig's and Leach's stays which need no explanation.

CORNELIUS E. CARDEW, M. Inst. C. E.,
Locomotive and Carriage Superintendent,
Burma Railways, Insein, Lower Burma.

[Wehrenfennig's staybolt is made as shown in Fig. 1. The Leach staybolt is shown in Fig. 2. The ends of the staybolts at the outer shell are formed with ball heads fitting sockets in brass bushings. The holes in the shell for these bushings are bored with a special boring tool. The holes are then tapped with a tap having a guide bar fitting the holes in the firebox sheets. The bushings are screwed in place and after the holes in the firebox sheets are tapped the stays are screwed up to their seats by the square ends. These ends are left and a sledge is held against them in the riveting, after which they are cut off. The stays are then completed by the insertion of the copper caps. These caps are punched to form from the sheet, and they are forced into place by a small hand screw press which is held under the heads of the bushings. The press flattens the cap slightly and forces the edge into the groove in the bushing, making a tight joint. The drawings kindly sent by Mr. Cardew fully illustrate the construction and the application of these staybolts, which are used for crown as well as side sheets. We are glad to record this successful experience which tends to show how few things are really new. Mr. Cardew gives valuable testimony to the worth of flexible staybolts in prolonging the life of the firebox. We believe that this result will repay a large investment in this direction.—Editor.]

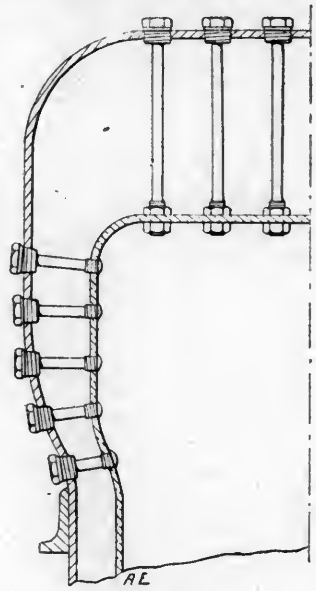


Fig. 3.

A SUGGESTION FROM SWISS PRACTICE.

To the Editor:

On page 290 of your September number is an article entitled "A Suggestion from Swiss Practice," and as I hold letters patent for the United States, Canada, Great Britain and France covering the practice, I do not feel flattered that it required effete Europe to bring to the attention of American railway officials what I have been importuning them for years to try.

In the New England States the writer is facetiously entitled "Spring-Suspension Graham," and the man who dared to say that the equalizer of locomotives was an antiquated relic which possessed no mechanical or other features to entitle it to a place upon a modern locomotive.

You have done the combination of leaf and spiral springs justice in stating that the arrangement is "attractive." Well, it is attractive, for the Czar of Russia and the President of France use it on their private trains. The International Sleeping Car Company of France have adopted it and we have shipped electric trucks all over the world fitted with this arrangement of leaf and spiral springs.

Although the device is attractive, no one but myself (on my own trucks) has had the courage to use only axle-supported springs. Others have been licensed to use it but have neutralized the advantages by using full elliptical bolster springs, which are entirely unnecessary.

Just one exception to your statement where you say: "The wheel beam must be strengthened." Quite the contrary; the entire truck frame can be considerably reduced both in weight and parts.

I have repeatedly stated in the technical papers, in my circulars and before the New England Railroad Club, that the spring-maker's art as applied to moving vehicles is a decided failure, and, if were permitted, I could build a four-wheel truck that would carry any car, no matter what the weight or speed, and would make a pair of them weigh less than one ordinary six-wheel truck.

I thank you most heartily for all you have said in favor of Swiss, or, more properly, my own, practice.

JOHN HECTOR GRAHAM.

Boston, September 19, 1900.

SPEEDS OF FREIGHT TRAINS.

The relation between speeds and the work which may be had from locomotives is shown in a novel way by Mr. F. P. Roesch, in a recent number of "Locomotive Engineering," under the caption "Economy of Speed." The road referred to presented the following conditions (quoted from the discussion):

"A road or division of 150 miles; engines with 20 x 24-in. cylinders and 60-in. driving wheels, capable of hauling 800 tons over the division at two-thirds stroke at an average speed of 10 miles per hour, or 700 tons at one-third stroke at an average speed of 17½ miles per hour."

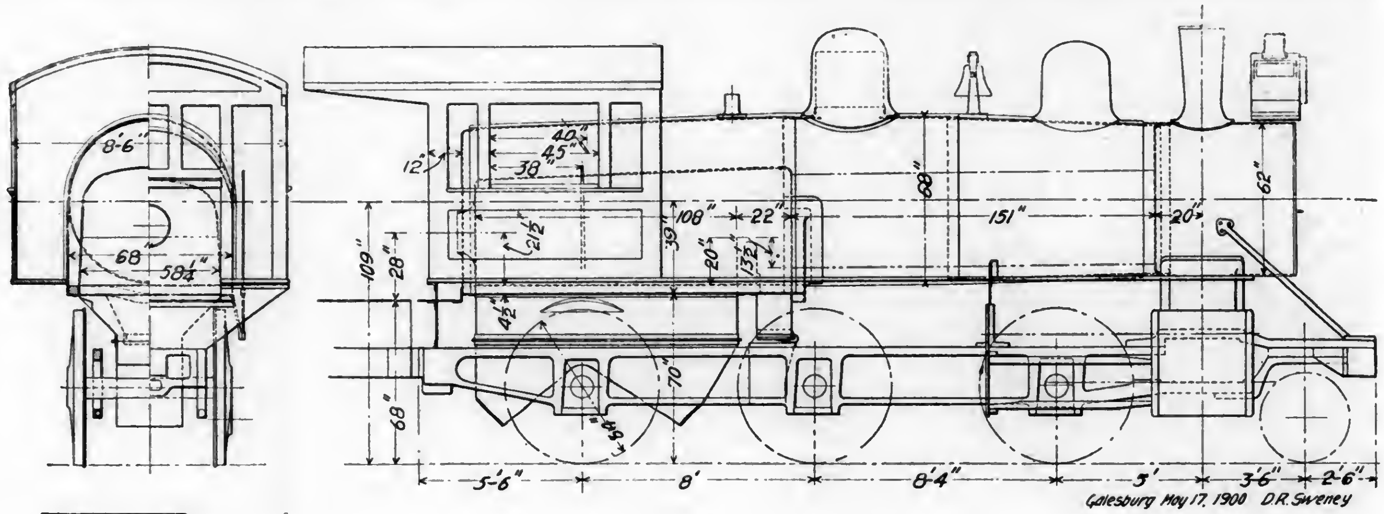
Combining two of the engines, which will be designated No. 1 and No. 2, we may give engine No. 1 a train of 800 tons and No. 2 one of 700 tons. Eliminating the fact that No. 2 with the lighter train can make better meeting points than No. 1—which is giving No. 1 the better of the argument—and assuming that each train can pass over the road without interruption, we find that No. 1, running at the rate of 10 miles per hour, occupies 15 hours in going over the division, while No. 2, whose speed is 17½ miles per hour, uses 8½ hours to go the same distance, a saving of 6½ hours in favor of No. 2.

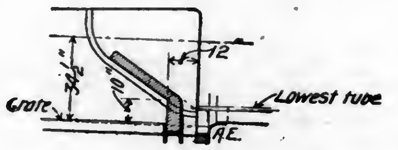
As engines on arrival at terminals generally require more or less work before going out again, Mr. Roesch allows each engine 7 hours for necessary repairs. Starting both trains from the same terminal, at the same time, we find that No. 2 is ready for the return trip 30 minutes after the arrival of No. 1, and at the end of 24 hours we find that No. 2 is again at the other end of the division, while No. 1 has made but 20 miles on the return trip.

Mr. Roesch then compares the ton miles for the two engines for 24 hours and shows that there is an advantage of 54 per cent. in the lighter trains and higher speed of No. 2. Allowing the same number of hours at the terminals, the train crew wages should be the same for both trains, and allowing $1.35 per hour for the wages of the train crews, the charges in each case would be about $23.

It is well understood that heavy grades affect the relation between fuel consumption and speed and on a hilly road the fuel cost would go up rapidly with the speed, but on a level on nearly level road the difference in speeds considered in this case would surely not adversely affect the fuel consumption, and if the cut-off of engine No. 2 is 8 in. and that of No. 1 half or two-thirds stroke the coal per ton mile would be less for No. 2. If the men are paid for units of 100 miles run, however, the figures of cost per ton mile change materially, although the advantage in the amount of freight handled by an engine remains with the one running at the higher speed.

There seems to be no doubt that in some cases engine ratings have been so large that the cost of repairs have been greatly increased. Up to a certain limit this is economical because of the larger ton mileage of service, but when carried to the point of keeping engines out of service a day or so at a time for repairs the limit of economical loading may soon be passed. The importance of moderately high speeds in saving delays on sidings has probably been underestimated. In many cases, especially on single track lines, the ability to get out of the way of other trains is more important than any other consideration in this discussion. We believe that there is a tendency toward slightly higher speeds in ordinary freight service.





A Design of Mogul Locomotive with Wide Firebox over Rear Driving Wheels.

DESIGN FOR MOGUL LOCOMOTIVE WITH WIDE FIREBOX.

By D. R. Sweney.

In the May issue of the American Engineer you illustrate a locomotive study by Mr. Grafstrom. He has presented a rather difficult problem, viz., an 8-ft. grate above 80-in. driving wheels and the center of the boiler 109 in. above the rails. The inside of the mud-ring is about 7 in. above and 21 in. outside of the wheel flanges. An ashpan located in the rear would require the use of blowers to keep the ashes from accumulating under the grates above the wheels. Too much care cannot be given to the design of ashpans to be used where the runs are long and the coal of a poor grade.

The method which he presents for compelling the gas and flame to traverse a sufficient distance before entering the flues is worthy of study. If you will examine the usual design of combustion chamber which extends into the barrel of the boiler and count the number of stays, you will find it about equal to the number required by the same length of firebox. The recent designs of anthracite burners would undoubtedly make efficient soft coal burners by putting in a bridge wall, as Mr. Grafstrom suggests and which I believe has been done before.

The arrangement which he presents shows the tendency of designers to try to make use of a very large grate area. Nothing can determine the proper area of grates for the use of soft coal so satisfactorily as experience, and the design must be developed step by step. It is reasonable to suppose that to add to the area of grate common on western roads, the first 15 sq. ft. would be of three times the value of a second 15 sq. ft., especially when the present area is so small that there is danger of the draft tearing up the fire. Experience seems to show that the screenings from many mines cannot be burned to advantage on long runs on any area of grate possible on a locomotive, and in such localities it would not be desirable to make the grate larger than necessary to burn mine-run coal with reasonable economy.

The use of the very large grate introduces some objectionable features into the design. If, however, these objections are such as to retard its introduction and it is possible to obtain three-fourths of the desired size without so many undesirable features, why not assume that three-fourths of a good thing is better than one-half and use it. The three-fourths might be found sufficient and would certainly direct the course for further development. It would seem wise in this, as in all experiments, not to introduce any more new and experimental details than are necessary to get the one desired end.

A change from the narrow grate between the wheels to a wider one above the wheels adapted to soft coal requires attention to the following points: (1) method of supporting the boiler and stiffening the frame toward the back end; (2) the height to which it is advisable to carry the boiler; (3) location of doors, deck, etc., to make convenient and efficient firing; (4) the location of engineer; (5) room under the grates for a good ashpan; (6) means for keeping the fire out of the flues and making the flame traverse some distance before entering the flues.

The accompanying plan of an engine is presented as an attempt to apply a larger grate with as few experimental details as possible. It is developed from a standard freight engine and is similar to the standard in most of its dimensions, which are as follows:

	Proposed engine.	Standard engine.
Boiler pressure	200 lbs.	200 lbs.
Cylinders	19 x 26 in.	19 x 26 in
Drivers	64 in.	64 in.
Heating surface	2,040 sq. ft.	2,040 sq. ft
Grate	108 x 58¼ in.	108 x 40¼ in.
Grate area	43¾ sq. ft.	30 sq. ft.
Firebox at bottom	130 x 58¼ in. or 120 x 58¼ in.	108 x 40¼ in.
Center of boiler above rails	109 in.	96 in.
Driving wheel base	16 ft. 4 in. or 15 ft. 10 in.	15 ft. 2 in.
Grates below lowest tube	6½ in.	20 in.

The firebox being lengthened toward the rear requires lengthening the driving-wheel base in order to distribute the weight properly. In many other cases the boiler could be set ahead. The method of supporting the boiler and stiffening the frames would be the same as with very wide fireboxes. The height of the center of gravity is less than that of many fast engines and must be well within the limit (which is not a very definite height). If there is room in a cab beside the present form of firebox there would still be room with the wider grates which would not increase the width of the upper part of the firebox, or if there is room in a cab beside the barrel of the boiler there would be room beside a firebox of the same width with vertical side sheets. By narrowing the upper part of the back end of the firebox, as is the usual practice with narrow grates, there would be still more room at the point most needed. This design does not need to affect the form of the upper part of the firebox and the manner of staying. The ashpan under a 5-ft. grate will require less room above the wheels than that for an 8-ft. grate. The bridge wall and the arrangements in front of it are subjects for experiment. The height which it is necessary to make the wall and

the distance which it should be located from the flue sheet are unknown, but experiments to determine this would not be expensive. By the use of arch tubes the box could be shortened 10 or 12 in., as the bridge wall could be low and an arch extended from its top at an incline backward as is usually done from the flue sheet.

It is interesting to study the adaptability of this form of firebox to some recent large freight engines. In many cases an increase of 40 to 45 per cent. of grate area could be obtained without any increase in the length or weight and with a reduction in the number of short stays and curves.

TABLE OF THICKNESSES OF BOILER SHEETS.

By F. K. Caswell.

Where many calculations have to be made from the same formula it often pays to adopt short methods, and I have prepared a table and description of the way of making it which may be of interest to the readers of the American Engineer.

The formula for the safe thickness of plates for circular courses is $t = \frac{F P D}{2 S \%}$ in which:

t = thickness of steel.
F = factor of safety.
P = maximum working pressure.
D = internal diameter of the course.
S = tensile strength of plate.
$\%$ = strength of riveted joint in per cent. of solid plate.

Only commercial thicknesses of plates are ordinarily used, therefore, if we decide on uniform values for S, % and F, using the lowest allowable limit in each, we can readily find the largest or limiting diameter for each 1/16 in. in thickness and each pressure.

By transposing, our formula now becomes $D = \frac{t\, 2 S \%}{F P}$ and substituting for S, % and F the values 54,000, .75 and 4 we have $D = \frac{20250\, t}{P}$. From this we can get a constant for each thickness, thus:

t =	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16
20250t =	7594	8859	10125	11390	12656	13922	15187	16453	17718	18984

By dividing each constant by the various pressures we can make a table of limiting diameters as given below, or by dividing by given diameters we can get the limiting pressure. The table given is used as follows:

Example I.: What thickness is required for a 64-inch course to carry 200 lbs. pressure?

In column 200 we find 64 in. between 63¼ in. and 69 9/16 in. or over ⅝ in., therefore the next regular thickness, 11/16 in., should be used.

Example II.: What pressure can be carried on a 62-in. boiler 9/16 in. thick?

On line 9/16 in., 63¼ in. diameter can carry 180 lbs., therefor, 62 in., being smaller, is good for 180 lbs. or a little more.

Thickness of Boiler Courses.

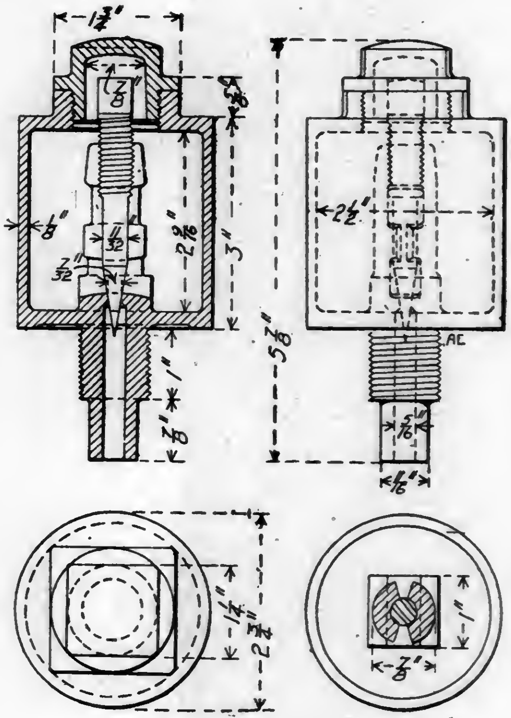
Pressure....	150	60	170	180	190	200	210	220	230
Safe thickness (inches).	Limiting diameters (inside).								
⅜	50⅝	47 7/16	44⅝	42 3/16	39 15/16	37 15/16	36⅛	34½	33
7/16	59 1/16	55 5/16	52 1/16	49 3/16	46⅝	44¼	42 3/16	40¼	38½
½	67½	63¼	59½	56¼	53¼	50 1/16	48 3/16	46	44
9/16	75 15/16	71 3/16	67	63¼	59 15/16	56 15/16	54 3/16	51¾	49½
⅝	84⅜	79 1/16	74 7/16	70 5/16	66 9/16	63¼	60¼	57½	55
11/16	92 13/16	87	81⅞	77 5/16	73¼	69 9/16	66¼	63¼	60½
¾		94⅞	89 5/16	84⅜	79⅞	75⅞	72¼	69	66
13/16				91⅜	86 9/16	82¼	78 5/16	74¾	71½
⅞					93¼	88 9/16	84⅜	80½	77
15/16						91⅞	90⅜	86¼	82½

The above figures are for steel of 51,000 lbs. per square inch tensile strength: riveted joint of 75% efficiency and a factor of safety of 4. Use maximum working pressure.

MALLEABLE IRON OIL CUPS.

Central Railroad of New Jersey.

Oil cups for main and side rods and other parts of locomotives are important beyond all proportion to their size. They are often made of brass, and have brass covers. The loss of the cover while running means a hot pin, and the loss of the entire cup and cover by thievery is a common occurrence which is explained by the present high price of copper and brass. The brass covers often become lost and they are usually replaced by tin; on one road, the New York Central, pressed steel is being considered for covers for cups where the covers may be slipped on without requiring a screw cap for security. For rods, malleable iron oil cups have been used for several years, and they are satisfactory in every way. The form illustrated was put into use on the Central Railroad of New Jersey about a year ago. It is cheap, efficient and looks well. The



Malleable Iron Oil Cups.

interesting features are the long tube at the bottom which takes the oil down into contact with the crank pin, the form of the base whereby a secure fastening to the rod is obtained and an excellent device for regulating the flow of oil. In many cups the tube at the bottom terminates with the threaded portion and this permits the oil to pass between the brass and the rod, while this long tube carries each drop down upon the pin itself. The form of the bottom of the cup is seen in the sectional views. It is thinned down in such a way as to obtain the assistance of the elasticity of the bottom of the cup to hold it against turning back after it has been screwed down firmly. To this feature Mr. McIntosh attributes the entire freedom from loss of the cups by unscrewing. The regulating needle is held in a split clamp in which a portion of the hole is bored four one-thousandths of an inch smaller than the needle. The friction thus obtained holds the needle where it is adjusted. It is the intention to use this regulating device on all oil cups put into use in future because of the advantage of using but one form of feeding device.

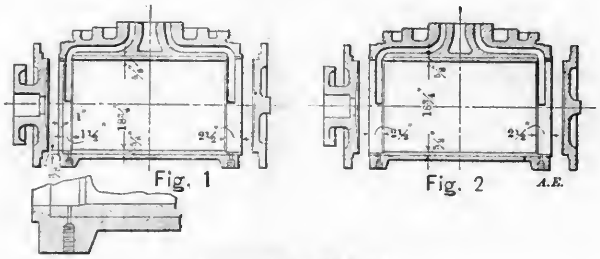
CYLINDER BUSHINGS.

By F. E. Seeley.

One of the questions asked by the committee of the Master Mechanics' Association, appointed to ascertain to what extent the standards and recommendations of the association are being carried out, relates to the use of bushing in cylinders. Out of about 50 replies to circulars sent out in this connection only half report as to the use of cylinder bushings at all, and the majority of these use them to only a very slight extent; the rest report no experience at all in the matter. They offer advantages which are perhaps not fully appreciated.

The use of bushings provides a way to reduce the bore of a cylinder and furnishes an excellent method of repairing worn and cracked cylinders, as well as a remedy for cylinders which are too soft to provide a good wearing surface. Probably no two practices agree precisely as to the method of applying bushings to worn cylinders and it will be worth while to discuss briefly one of the best.

After allowing, say, a 19-in. cylinder to wear ¾-in. in diameter, or to 19¾ in., it is rebored to 1 in. larger diameter—that is, to 20 in.; then a bushing 20 in. outside diameter and ⅝ in. thick is inserted, bringing the diameter of the cylinder to ¼ in. less than normal size, or to 18¾ in. Ports corresponding in size and location with those in the cylinder are cut in the bushing, cylinder cock holes are tapped, and the bushing is counterbored as would be the cylinder. Some practices call for a bushing whose outside diameter is 1/100 in. greater than



Cylinder Bushings.

the inside diameter of the cylinder, but in most cases they are made the same size with good results. To insert the bushing it is necessary to heat the cylinder. This may be conveniently done by placing hot bars of iron, of about the length of the cylinder, on pieces set across the cylinder a little below the center so that the heat may be uniformly distributed. When the cylinder has expanded sufficiently the bushing is put in. This must be done as quickly as possible, as the bushing being thin expands immediately on coming in contact with the hot cylinder, and little time is allowed for adjusting. The cylinder and bushing cooling together make a nice fit, and when the front head is put on there is very little possibility of the shifting of the bushing. A pin, however, is sometimes inserted through the cylinder and bushing near each end to insure against movement.

It may be well to mention two of the most common ways of fitting bushings. Both have given perfect satisfaction and both have their advocates. One method is shown in Fig. 1. As the cylinder wears and is rebored, an inch ledge is left untouched at the back end of the cylinder. The diameter of a 19-in. cylinder at this point would thus remain 19¼ in. (assuming the counterbore to be ¾ in.). When the cylinder is finally rebored to 20 in. for a bushing, this inch ledge, which is now ⅜ in. high, furnishes an excellent face against which to drive the bushing; in which case the bushing is counterbored an inch less at the back than at the front end. In this method the wearing face for the back head is not destroyed and there is consequently one less chance for leakage.

In the second method, as shown in Fig. 2, the bushing is made the full length of the cylinder. It is driven up against the back head, and held there by the front head. This requires a little more care, but makes a nice job and seems to be the method most generally adopted.

The use of bushings is, however, not by any means confined to worn and cracked cylinders. There are several advantages in the application of bushings to new cylinders which it will be well to consider. A good cylinder casting should possess two qualities: First, the body should be strong and tough to withstand the sudden and variable strains to which it is subjected. Second the wearing face should be hard in order to secure a good polish and furnish a good durable wearing surface. In a single casting these two considerations are directly opposed to each other, and in providing for one the other is neglected, and in a compromise between the two the best results are not obtained. In providing the necessary softness for the first the wearing surface is sacrificed, frequent reboring is necessary, and the friction between the cylinder and piston is increased. In providing the right degree of hardness for the second the casting is rendered less tough and not as well adapted to stand the excessive strain. Frictional resistance between the cylinder and piston consumes a large amount of power, and by the use of a bushing harder than can be obtained in an ordinary cylinder casting a decided economy in the above respect is produced.

It thus seems that, as in the case of false valve seats, the best results will be obtained when the body and the wearing face of the cylinder are made in separate pieces and each piece is designed and made to best meet the particular conditions to which it is to be subjected.

The largest floating dry dock in the world has recently been purchased from the Spanish Government by the United States for the sum of $250,000. This dock was built for the Spanish Government in Birkenhead, on the Mersey, England, in 1897, at a cost of nearly $600,000, for use in Havana Harbor. It is 450 ft. long, 82 ft. wide, weighs 4,400 tons, and has a lifting capacity of 10,000 tons. The operation of the structure is comparatively easy, and is accomplished by hydraulic power. The dock is divided into a series of water-tight compartments on each side of the keel, called the load balance, and air chambers. These are distinct from each other. When docking a man-of-war they are filled with water, which sinks the dock to a depth of 27½ ft. The ship is then brought over the blocks and centered, after which the water is pumped out and the dock rises, lifting the ship. This new dock will be placed at Pensacola, Fla.

A substantial application of 38 miles of automatic block signals is being made on the Chicago end of the Chicago & Alton Railroad. There will be 43 home and 50 distant signals of the semaphore type, operated by electric motors which are controlled by track circuits. The signals stand nominally in the horizontal position and the distant signals will be cleared when the trains arrive at a point about 1,200 ft. from them, so that the enginemen will be able to see the signals go to the clear positions. The distant signals will use yellow lights when horizontal. All switches within the limits of the application are connected with the signal circuits so that an open switch will put the signals to "danger" in that portion of track in which the open switch causes danger. At the switches bells are located and these will ring upon the approach of trains as a warning against opening the switch before the train has passed. It is a very complete system of automatic signaling, the noteworthy feature being the use of automatic electric semaphores.

Mr. F. A. Barbey, 185 Summer Street, Boston, has been appointed representative of the Standard Pneumatic Tool Company for the New England States.

NEW FILLING VALVE FOR PINTSCH CAR EQUIPMENT.

An improvement in the filling valve for the car equipment of Pintsch apparatus has been developed and tested and is now ready for application in place of the old valves. Its purpose is to more thoroughly control the possible leakage around valve stems when filling the receivers, thus preventing the escape of gas. The new valves are made in accordance with the improved design, which is illustrated in the accompanying engravings.

The bonnet fits the regular valve body (known as No. 65) and the cover (known as No. 89) needs only a new bonnet cap,

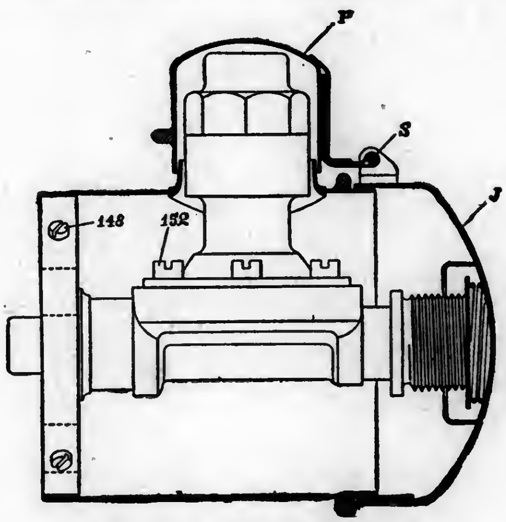


Fig. 1.—Filling Valve and Cover.

P, to make it applicable to the new valve. The valve carrier, L, has a square extension on the bottom of which the disc, O, is placed. This extension passes through the square opening in the bottom of the bonnet, N, to prevent the carrier from turning. The valve stem, K, is held between the valve-stem nut, M, and the packing nut, R. The packing, Q, is forced more tightly by turning the packing nut, R. It will be seen that the valve carrier may be removed and new one substituted by simply removing the packing nut, R. The pitch of the threads on the packing nut, R, and the bonnet, N, is the same

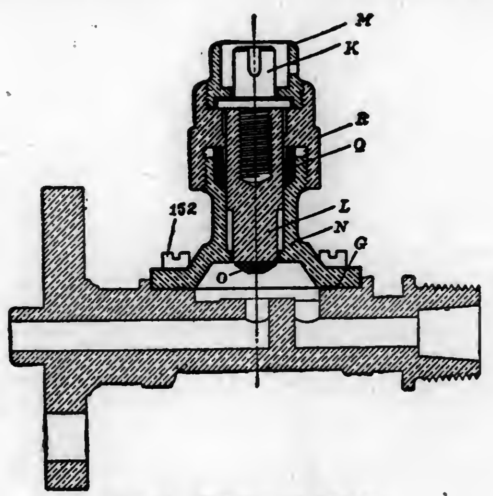


Fig. 2.—Section of Valve.

as on the valve stem, K and the valve carrier L, therefore tightening R on N will not jam the valve. To place the cover on the valve it is necessary to remove the packing nut, R.

In accordance with the custom of the Safety Car Heating & Lighting Company such improvements as this are always submitted to long-time tests in regular service, and it is now brought to the attention of the railroads with the hope that all valves in use will be rapidly changed.

IMPACT TESTS.

Metals which adjust themselves under the pull of the tensile test and hold up to the requirements for strength and elongation are by no means always able to transmit and distribute the vibrations which are set up in the outermost parts of the metal by the impact test.

Dr. C. B. Dudley, Chemist of the Pennsylvania Railroad, gave, in response to a request from the committee appointed by the American Section of the International Association for Testing Materials, his judgment in the matter of impact tests as follows:

"We are getting more and more experienced all the time, we are constantly trying to test material just as we put it in service, rather than a piece of it; that is to say, we test a whole axle rather than a piece cut out of it; we test a whole carwheel, rather than a fragment of it, and so on. Obviously, for this purpose either very large testing machines are required or else we must use the impact test. We have accordingly expanded quite a little in recent years in impact testing, and with the construction of machines which the Pennsylvania Railroad requires, we are inclined to think that the impact test is a genuine, scientific test, provided, of course, that deflection is taken as one of the elements. In our judgment impact testing will continue to increase."

Dr. R. Moldenke, Superintendent of the Pennsylvania Malleable Company, in answer to the same committee, said that the impact test was a most important one, because the majority of finished materials fail through vibration or shock. The heaviest breakages in couplers, guardarms excepted, is in the lugs. An inspection of tens of thousands of these breakages would give an impression that they were all pulled off, and yet close investigation reveals the fact that 80 per cent. were first battered up by impact and then pulled through the cracks. Here is explained the tendency to call for high tensile strength, when really what is wanted is high resistances to impact. The railroads are, with hardly an exception, using the impact tests in buying axles and automatic car couplers. There is also in the minds of some the idea of testing bolsters by these tests, which, in Dr. Moldenke's opinion, is a good step toward keeping materials up to the proper standard.

PIECE WORK VS. PREMIUM PLAN.

The distinction between the premium plan and ordinary piece-work is consistently and continually urged by the "American Machinist." Mr. F. A. Halsey, whose name is prominent in this connection, recently answered a correspondent through its columns with the following clear statement of the fundamental differences between the two systems:

No employer can contemplate paying the same wages cost per piece for his product 10 years from now that he does today. He must contemplate and expect a steady reduction of these costs. With piece-work this can only be brought about by cuts in the piece prices, with demoralizing effects. It will thus be seen that while these cuts are, from the workman's standpoint, the embodiment of injustice, they are, from the employer's standpoint, a matter of necessity.

Piece-work professes to give the employee all the gains due to his efforts, but in fact does not do it, because of these repeated cuts, which cannot be avoided. The premium plan promises less to the workman, but carries out its promises. Under any system it is impossible that the workman should in reality receive all the gains due to increased output, because that means stationary wages cost to the employer.

The chief merit of the premium plan is that a steady reduction in cost is brought about automatically, without any change in the agreement under which the employee works.

FLANGE WEAR OF CAR WHEELS.

Excessive flange wear of freight car wheels becomes more troublesome as wheel loads increase and the increasing amount of discussion of the reasons for it indicate its importance.

A careful review of the subject suggests the necessity for looking to the character of the trucks with reference to their ability to hold the axles in parallel, the importance of having on each axle, wheels of equal diameters, the ability of the bolsters to keep the side bearings apart (or the use of roller bearings), the employment of trucks which shall retain their shape and ability to properly perform their functions under the several shocks of service and means for lubricating center plates.

The best recent statement of the truck situation that we now recall is that by Mr. E. D. Bronner, of the Michigan Central. Mr. Bronner said (M. C. B. proceedings, 1898, page 74): "The diamond frame type of truck was a better type for small capacity cars than it will be for those of 60,000, 80,000 or 100,000 lbs. capacity." And also: "From my point of view a plate truck . . . (mentioning a number of pedestal trucks) is the most efficient truck for cars of large capacity. Properly designed and built in the proper manner, with the right material, they will retain their shape in service, thus reducing train resistance and flange wear."

We are inclined to believe that this idea and the other points mentioned cover the flange wear difficulty, and, as Mr. Hubbell said recently before the St. Louis Railway Club, that it is not "the result of any one thing, but the effect of a number of causes." Its effects are to increase the expense of car repairs and to greatly increase the cost of hauling trains on account of the increased train resistance.

The lubrication of center plates is one of the most important factors in this question. It applies to all trucks, whether with roller side bearings or not, and affects the flange wear independently of the character of the bolsters. The effect of lubrication was strikingly shown in our July number in connection with the description of the Dayton center plate.

KRUPP STEEL WORKS.

Probably few appreciate the great extent and large capacity of the Krupp steel establishments in Germany. In a communication from Frankfort, Consul-General Richard Guenther sends the following interesting summary:

The annual report of the Chamber of Commerce for the district of Essen contains statements concerning the cast-steel works of Frederick Krupp. These comprise the following: Cast-steel works, at Essen; Krupp steel works, formerly F. Asthower & Co., at Annen, in Westphalia; the Gruson works, at Buckau, near Magdeburg; four blast furnaces at Duisburg, Neuwied, Engers and Rheinhausen (this latter consists of three furnaces, with a capacity for each of 230 tons per twenty-four hours); a foundry at Sayn; four coal mines (Hanover, Saelzer, Neuack and Hannibal), with interest in other coal mines; more than 500 iron mines near Bilbao, in northern Spain; shooting grounds at Meppen, with a length of 10⅝ miles and a posibility of extension for 15 miles; three ocean steamers, several stone quarries, clay and sand pits, etc. In addition, the firm of Frederick Krupp operates the Ship and Machine Stock Company Germania, at Berlin and Kiel, under contract.

The most important articles of manufacture of the cast-steel works at Essen are cannon (up to the end of 1899 38,478 had been sold), projectiles, precussion caps, ammunition, etc.; gun barrels, armor plates and armor sheets for all protected parts of men-of-war, as also for fortifications; railroad material for shipbuilders, parts of machinery of all kinds, steel and iron plates, rollers, steel for tools and other purposes. The steel works in 1899 operated about 1,700 furnaces, forge fires, etc., about 4,000 tool and work machines, 132 steam hammers of from 200 pounds to 5,000 metric tons force, more than 30 hydraulic presses (among them 2 of 5,000 tons each, 1 of 2,000 tons and 1 of 1,200 tons pressure), 316 stationary steam boilers, 497 steam engines with an aggregate of 41,213 horse-power, 558 cranes of from 400 to 150,000 tons lifting power. During the last year the iron mines yielded an aggregate of 1,877 tons of ore per day. The coal production from the mines belonging to the Krupp Company (excepting the Hannibal) amounted, on an average, to about 3,738 tons for each working day.

The consumption of coal and coke in 1899 was as follows: In the cast-steel works at Essen, 952,365 tons; in the other works and on the steamers of the company, 622,118 tons; in all, in round numbers, 5,000 tons per day. The consumption of water at the cast-steel works in 1899 was 15,018,156 cubic meters, which equals about the consumption of the city of Frankfort with 229,279 inhabitants. The consumption of gas in the steel works at Essen was 18,836,050 cubic meters in 1899.

The electrical power plant of the works at Essen has three machine houses with six distributing stations, and supplies 877 arc lights, 6,724 incandescent lamps and 179 electric motors.

For the traffic of the works, railroad tracks of standard gauge of about 36 miles, are laid, which connect with the tracks of the main railroad station at Essen. Sixteen locomotives and 707 cars are operated on the grounds. In addition there are narrow-gauge tracks of 28 miles, with 26 locomotives and 1,209 cars.

The telegraph system of the steel works has 31 stations, with 58 Morse telegraphic instruments and 50 miles circuit. The telephone system has 328 stations, with 335 telephones and a circuit of 200 miles.

On April 1, 1900, the total number of persons employed in the different works was 46,679, viz., 27,462 at Essen, 3,475 at the Gruson works of Buckau, 3,450 at the Germania works at Berlin and Kiel, 6,164 in the coal mines and 6,128 at the blast furnaces and on the testing grounds at Meppen, etc.

Illustrated Catalogue of the "Four Track Series." The passenger department of the New York Central & Hudson River Railroad has found it necessary to issue a catalogue of their publications. It is in the form of a 40-page illustrated pamphlet and will be sent free to any address on receipt of a 2-cent postage stamp by Mr. Geo. H. Daniels, General Passenger Agent, Grand Central Station, New York.

A surprising prediction by Mr. Nicola Tesla concerning long-distance electric transmission was recently included in an interview with the inventor printed in the New York "Sun." He is reported as saying: "The limitation which we still have to contend with is the loss in the transmission to a distance, and this, I hope, with my latest improvement, to do away with almost entirely, and I think that the time is not far off when we shall be able to transmit with wires buried in the ground, power from Niagara to New York City, with a loss not exceeding one-half of one per cent."

James Ball, an engineer on the Kansas City, Fort Scott & Memphis, has just resigned, after almost 49 years' service in a locomotive cab. He is 68 years old, and said to be the oldest engineer in the United States in the matter of uninterrupted service. The New York "Commercial" states that in spite of his age he was able recently to pass a satisfactory examination for sight and hearing. His retirement was voluntary. Mr. Ball's record is of unusual interest. At the age of 20 he was firing an engine on the Cleveland & Pittsburg, and in 1855 became a locomotive engineer. Three years later he was employed on the New Orleans & Western, and in 1861 entered the Government service, having charge of the engine that pulled the last train of Federal troops from the scene of the second battle of Bull Run, and nearly losing his life. This was on the Alexandria & Orange. In 1862 he was on the Erie, and later went to the Central Pacific. His connection with the Memphis began in 1878.

GOOD STAYBOLT PRACTICE.

The opinion from the extensive experience of Mr. Archie Baird, foreman boilermaker of the A. T. & S. F. Ry., upon the best methods of fitting locomotive staybolts is summed up in the "Railway and Engineering Review" as follows:

In new boilers, keep under 4 in. centers in spacing; that is necessary to maintain about double the factor of safety in the staybolted portion over that of the cylindrical parts of the boiler, and adds greatly to life of bolts.

When the renewal of a firebox becomes necessary, do not have too many different sizes of bolts. If it is found that the casing sides will tap out part ⅞ in., 15-16 in. and 1 in., it is the better way to make the box 1 in. throughout.

Under no circumstances use a staybolt to exceed 1 1-8 in. diameter. Bush the casing side rather than use a large bolt.

Have the bolts cut so as to show a clean, smooth thread, avoid taper, and see that the bolt does not run out of 12 threads per inch its entire length.

Do not have the bolts made to run into the sheets too tight. An easy bolt run in without strain will give better results than one going in too tight, for the staybolt does not depend on the threads for strength—rather the opposite, for a physical test will make it evident that a plain bolt, put in a plain hole and riveted over like an ordinary threaded staybolt head, will stand from 1,000 to 3,000 lbs. more than the threaded bolt will before pulling through. The thread simply acts as a shoulder to help stay sheets that are subjected to intense heat. Aside from this one feature, the thread on a bolt would not be an actual necessity.

Modern railroading has abandoned the old 5 and 6-ft. boxes, and the old steam pressure of 130 to 150 lbs. per sq. in., in favor of 8 and 10-ft. boxes and 180 to 200 lbs. steam pressure. This change of conditions has come about within 10 years and must be met and looked upon as a very radical change. Of course, we try to hold the safety factor by an increased thickness of plate, rivets, etc., but nevertheless we stand on more dangerous ground than heretofore, and my plan would be not to experiment any longer with the different kinds of double-ended or concave section bolts, but to apply a clean cut, threaded staybolt, made of good, honest charcoal iron. Then to test the boiler every 30 days, and alternate every second bolt with new ones, so as not to exceed 2 years' life for any one bolt in the entire boiler in a bad water section. In a good water section, to renew 5 rows in the offset, 2 top rows and 1 row next to the flanges of the door and flue sheet in the same time. It is my belief that this, in addition to the other recommendations, is the best method of applying staybolts where the best possible life is desired in the interest of safety.

A SCHEDULE FOR APPRENTICES.

On the Chicago & Northwestern Railway two classes of apprentices are taken—regular and special. The first are those who have had but a common school education, and are taken for a four years' course. The latter are those who have had a technical education, and these serve three years.

They have the following course alloted to them:

Regular Apprentices.

	Months
Tool room	3
Machines	15
Erecting floor	12
Rod and vise	6
Laying off	3
Drawing room	6
Test work	3

Special Apprentices.

	Months
Machines	9
Erecting floor	12
Rod and vise	6
Drawing room	6
Test work	3

The time divisions of the schedule are in multiples of three months, and a convenient chart is used, giving at a glance the location of each apprentice in the shop. This is arranged as indicated in the accompanying table, in which each apprentice is represented by an initial. Special apprentices are now taken in July, and these will be placed among the squares in such a way as to distribute them and avoid getting too many together. This plan is described in a brief paper by Mr. G. R. Henderson before the Western Railway Club, which concludes as follows:

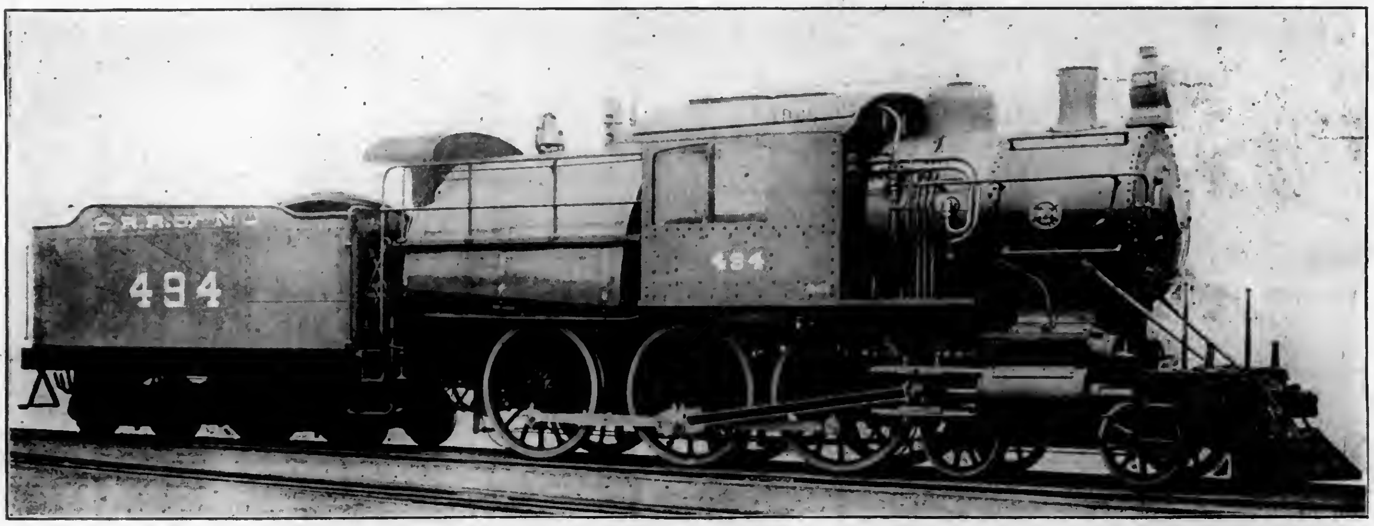
"Of course these plans are not entirely unselfish on the part of the company, as we desire to have thorough mechanics, who will be eligible for promotion, and some of our most promising foremen of the present day are those who have gone through the course in our shops. We look to these for prospective master mechanics. The whole scheme has been outlined with the idea of giving every opportunity for the apprentice to develop into a valuable mechanic, and, later on, an officer of the railroad, provided he has the necessary qualities in him."

Year	1900				1901				1902				1903				1904			
Quarter	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Tool Room	S.T.	T.	Y																	
Machines	* M.A.H. K.L.B.N. O.P.Q.R.	I.S.K.N. O.P.Q.R. *B.*A.	F I. J. K. N.O P Q. R.S.T.V W.X.	F I. J O. R.S.T V. W.X.Y.	F J O R. S. T. V W.X.Y.	S.T Y	T.Y	Y				U	U.	*U						
Erecting Floor	D.I.J.C. P.	C D F.G H.J	C.D E G H.U.	C D.E.G H.K.N.P. U.	E.G.H.N. K.P.U.	E.K N.O. P R U.V. W.	K.N.O P. R. S V. W.	O.P.R.S. T.V.W.	O.R.S.T V.Y	S.T V	T.X Y	X.Y.	X	†X †W.						
Rod and Vise	E.G.	E			D.I	†J.X.	U.X	K.N.	†N P	P R V	O.R.S.	S.T.W.	T W Y	†V Y						
Laying Off						†I		U.	K	Q	P	R	S.	T	Y					
Drawing Room				Q	*C.O.	*D G H	*F H	X	U.X	K U.W	K V W.	O.P V	O.P	R S	*R.S	*T.Y	Y			
Test Work						*Q.F	*E *G	*H	W	X	U	*K	R V	*O.*P.	T	*S		*Y		

NOTE.—* Regular apprentice out of time. † Special apprentice out of time.

Chicago & Northwestern Railway. Schedule of Work for Chicago Shops. Machinist Apprentices.

The Ashton Valve Company, 271 Franklin Street, Boston, have been informed that the Jury of Awards of the Paris Exposition have awarded them three medals, one silver and two bronze, upon their exhibit of pop-valves and gauges, the silver medal being the highest award that was possible to obtain in this class of exhibits.



Ten-Wheel Wide Firebox Locomotive.—Central Railroad of New Jersey. For Passenger and Fast Freight Service.

TEN-WHEEL, WIDE FIREBOX LOCOMOTIVES.

Central Railroad of New Jersey.

Built by the Brooks Locomotive Works.

This road has received a number of wide firebox locomotives of the 10-wheel type from the Brooks Locomotive Works for fast freight service, the design being such as to render them equally well adapted to heavy passenger service. They have piston valves and tender water scoops, and when tried on passenger trains of the Long Branch & Point Pleasant Division they gave very satisfactory results. They are now running on this division, and Mr. McIntosh speaks very highly of their work.

The grates are a combination of water tubes and shaking bars of the Yingling type, which have been very successful in stationary practice. Instead of the usual rocking arrangement these shaking grates are placed so that the fingers of adjacent grates interlock and grind the cinders so that they will pass down through. The fingers are made small in section to prevent burning. The tenders carry 5,000 gallons of water and 12 tons of coal, which is fine anthracite, used extensively on this road. We have the following items from the specifictaions:

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Total of tender and engine	274,500 lbs.
Boiler pressure	210 lbs.
Cylinders	20 by 28 in.
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Heating surface, firebox	174 sq. ft.
Heating surface, tubes	2,338 sq. ft.
Heating surface, total	2,512 sq. ft.
Grate area	83.3 sq. ft.
Tubes, number	325
Tubes, diameter	2 in.
Tubes, length	13 ft. 10 in.
Driving wheel base	13 ft. 6 in.
Engine wheel base	24 ft. 9 in.
Total wheel base	50 ft. 9 in.
Valves	Brooks, piston
Fuel	Fine anthracite

A new, and probably popular, rule regarding uniforms for passenger trainmen has been adopted on the Chicago & Alton. The company will present one new uniform each year to each employe who obeys the rules strictly and who has held the same position in the employ of the road for five years. Two uniforms—one winter and one summer—will be given annually to each employe who has held the same position for ten years.

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As in these days all of the problems in the science of transportation—even those that are purely mechanical—must be solved in the clear light of net earnings, the question of the money cost of maintenance of equipment becomes of interest to the heads of the department. One important line, the Atchison, Topeka & Santa Fe, shows categorically in the annual reports the average cost of repairs and renewals per locomotive, per passenger car and per freight car. Perhaps others do likewise. The practice is admirable and might well be extended.

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Considering the fact that, in the hard times of 1895 and 1896, maintenance of equipment was avowedly slighted to a considerable extent, the showing for 1898 presumably is nearer actual normal requirements than that for 1895, for example. On the other hand, many roads make special appropriations of revenue for the benefit of the equipment department without carrying the money through the operating expense accounts.

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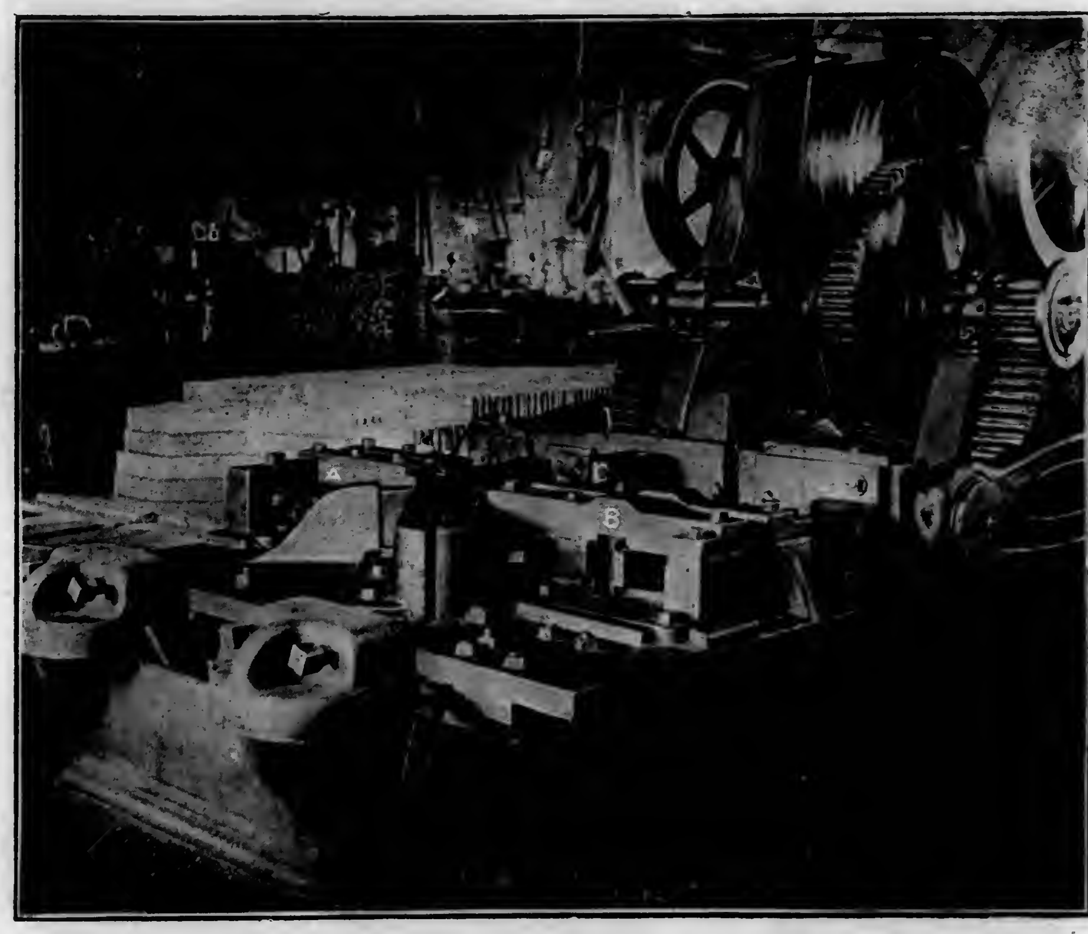

The machine is known as Williams, White & Co.'s No. 5 Standard Bulldozer, and is well suited for heavy work. From the engraving it will be seen that the live head is moved to and from its work by side rods, which are in turn operated by two pairs of large and small gear wheels driven from an overhead shaft. Suitable bed-plates are used in connection with the female dies and bolted to the frame of the machine, while the male dies are bolted to the live head.

One of the more complicated operations is performed by the dies shown in the engraving. They are used in turning down the ends of the tension members of body bolsters. The movements of the live parts of the female die are at right angles to the path of the male die and receive power from two heavy tongues bolted to the head of the machine and work through slots in the die housings and dies. The curved-out line of these tongues has a cam action that gives the required length of stroke to the dies as the tongues are forced through the slots.

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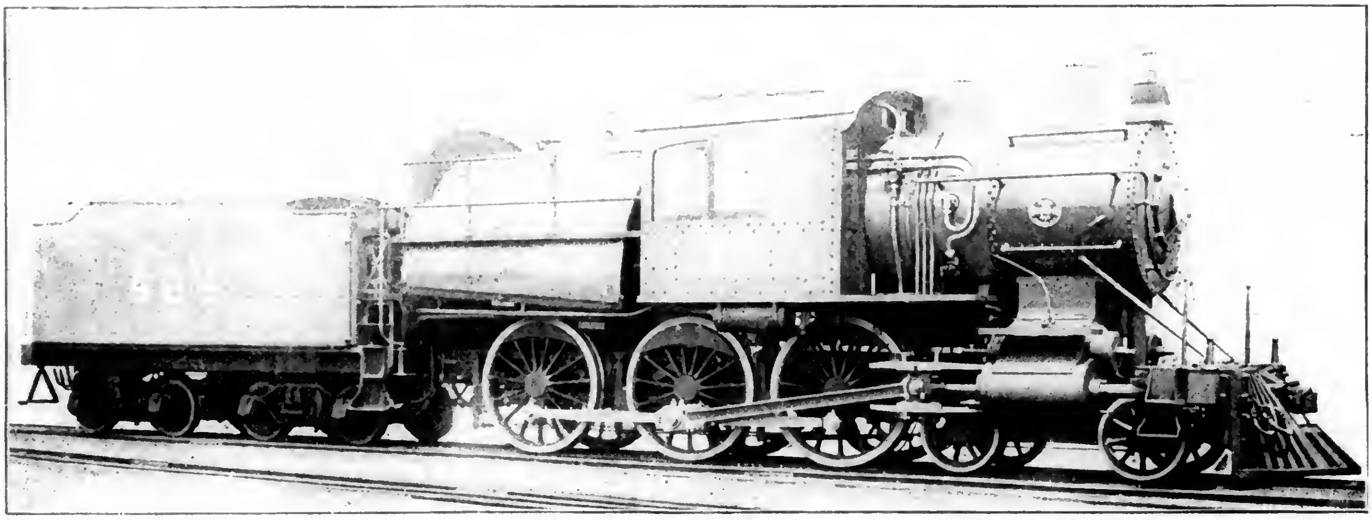

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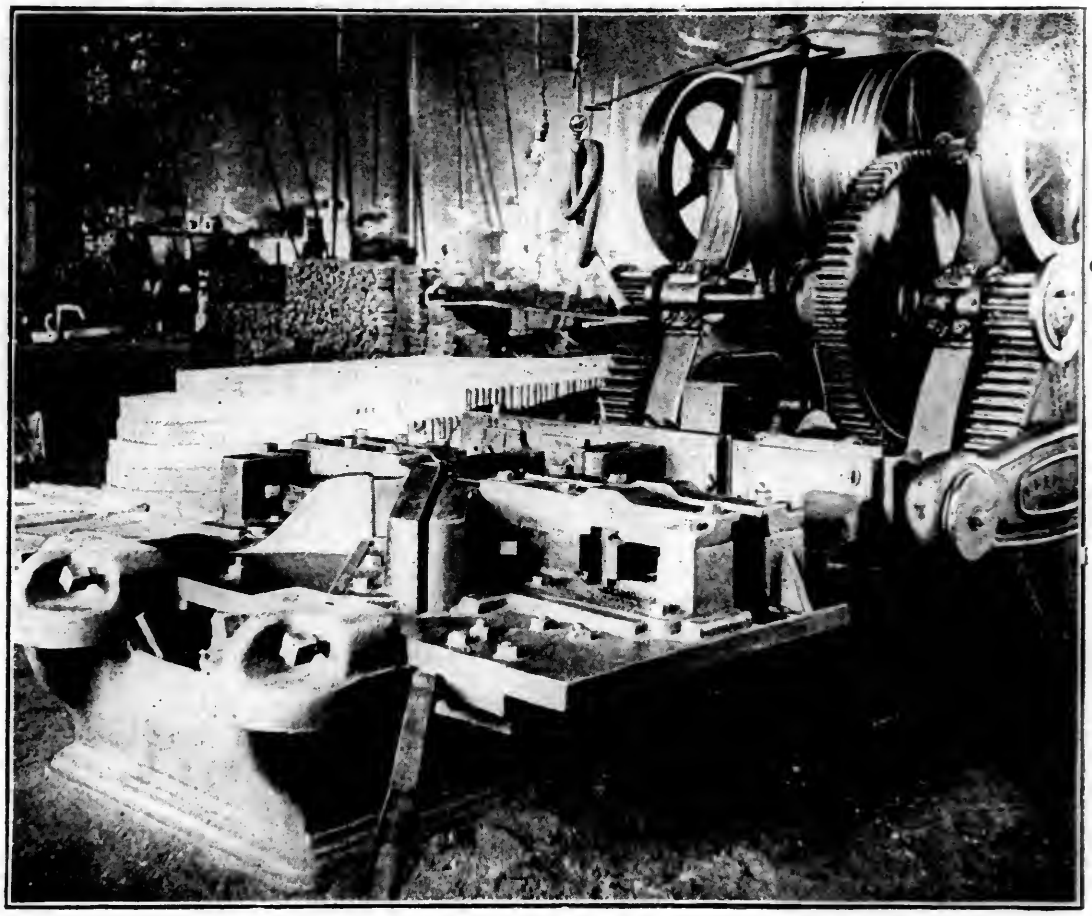

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BOOKS AND PAMPHLETS.

Proceedings of the American Railway Master Mechanics' Association Thirty-third Annual Convention. Held at Saratoga, N. Y., June, 1900. Edited by Jos. W. Taylor, Secretary of the Association.

This volume, as usual, contains the constitution, lists of officers and members, and the proceedings of the convention. It is uniform in binding with other recent volumes, and is, as usual, ready for distribution at a remarkably early date after the close of the convention. This volume contains a specially valuable list of subjects treated by the association since the first meeting, with the important reports and decisions indicated in heavy type. We also note that in a number of the reports marginal captions have been used. This is an improvement which will be greatly appreciated by those who have occasion to refer to the proceedings.

Universal Directory of Railway Officials. Published by the Directory Publishing Company, Limited, 8 Catharine Street, Strand, London. Sole representative in the United States, E. A. Simmons, 697 Chauncey Street, Brooklyn, N. Y. Pages, 563. Price, $2.50.

This is the sixth annual edition of this valuable publication. It contains a list of the officials and information concerning the gauge, mileage and equipment of the railways of the world. It includes a convenient alphabetical finding list of the officials and is printed in a convenient style. This year the portion of the list concerning South African roads is not offered as accurate because of the effects of the war, but otherwise the information is offered as official. It is compiled by S. Richardson Blundstone, editor of "The Railway Engineer."

Proceedings of the Western Railway Club. Vol. 12, 1899-1900. Published by The Western Railway Club, 667 Rookery Building, Chicago, 1900.

This is the only railroad club placing before the members the proceedings of the year in a bound and indexed volume. No better method of expending its money can be imagined, and we think it much wiser to increase the value of membership in this way than to indulge in frequent lunches and an annual dinner, which seems to be growing in popularity in other railroad clubs. The money expended in these affairs, which are, of course, very enjoyable, would seem to be better invested in the way the Western Club has practiced for two years. The volumes resemble the form adopted by the M. C. B. and M. M. Associations, and the proceedings under notice are worthy of a place beside those of the national organizations.

The Work of Railroad Men on the Problem of Pure Water for Steam Boilers. By C. Herschel Koyl. Reprinted from the Railroad Gazette.

This little pamphlet is issued by the Industrial Water Company, 15 Wall Street, New York. It contains a review of the reports and discussions at various times before the Master Mechanics' Association upon the purification of feed water. The chief deduction from the reports is that water should be treated before it goes into the boiler. At the end of the pamphlet appears a statement by the Industrial Water Company concerning their apparatus for continuously and automatically purifying water, the total cost of operation of which, including interest on the plant, is stated at five cents per thousand gallons or less. The cost is contrasted with that of the average damage to locomotive boilers, which was placed by the Master Mechanics' Association at about fifty cents per thousand gallons. It is a good investment to buy water for locomotives at thirteen cents, a common price for city water, but a still better one to provide water better than ordinary city water at a cost of from four to five cents. This company invites those having trouble with boiler waters to send gallon samples of the water with a statement of the amount used per day and they will estimate the cost of purification. This is a most important subject. Bad water not only increases the cost of repairs, but it is also expensive in keeping locomotives out of service for the repairs and for the regular washings.

Railroad Construction, Theory and Practice. By Walter Loring Webb, Assistant Prof. Civil Engineering, University of Pennsylvania. Published by John Wiley & Sons, New York, 1900.

Notwithstanding the numerous hand-books that have been issued on railroad curves, location and computation, this book gives the essentials of alignment and location in as concise and satisfactory a form as the best of them, leaving out much of the useless material that litters up some of the hand-books. On the subject of construction, however, the work is in many ways deficient. It is necessarily a compilation of data and designs, but it omits much that might be looked for in such a publication. On the subject of culverts and arches, for example, structures of concrete and of concrete and steel in combination are entirely omitted, although the most conservative engineers will admit that these types are coming to play a most important part in the economy of railroad construction. The discussion on tunnel practice contains but little of modern methods. In earthwork, the book summarizes much of the already existing information and also adds a great deal that is new and useful in approximate methods of computation. And the cost of moving earth is treated more comprehensively probably than in any other existing text. For contractors interested in the cost of excavating, hauling, and filling this book contains probably the most satisfactory treatment of the subject, whether for railroad work or general construction. Finally, the book contains numerous logarithmic, trigonometric and curve tables, as well as functions for transition curves and tables for estimating road work or general construction. The book containing what has hitherto been found only in widely scattered texts, and has added much original material. The book occupies a field that has been treated by other authors only in a fragmentary way.

The John Davis Company, 51 Michigan Street, Chicago, have issued a new catalogue of steam fitters' supplies, wrought iron pipe, tools, including almost every conceivable item which may be wanted in connection with steam piping or heating systems. It is compact in form and its 294 pages are filled with everything that one would look for from a firm supplying the wants of steam users. It is indexed and the prices of nearly all the specialties are given.

Drop in Alternating-Current Lines.—The Westinghouse Electric & Manufacturing Company have issued in good form a pamphlet entitled "Drop in Alternating-Current Lines," which is a reprint of an article by Ralph D. Mershon, which treats of a method for calculating drop in alternating circuits. This pamphlet is supplemented by a short illustrated description of the Westinghouse Type F compensator, which records at the power station, without the use of pressure wires, the voltage delivered to the load regardless of the nature of the load. The description also includes tables for setting and instructions for the adjustment of the instruments.

Electric Power.—A very handsomely illustrated catalogue has been issued by the Westinghouse Electric & Manufacturing Company showing some of the many ways in which the Westinghouse electric motors are used for industrial purposes. The book does not give a description of the motors, but simply a caption, explanatory of the service to which that particular motor is applied, and depending on the excellent collection of 61 half-tone engravings for telling the story. The printed matter is in four languages, French, English German and Spanish. The catalogue is intended for distribution at the Paris Exposition.

"Three Points of View" is the title of a compact presentation of the merits of the turret lathes manufactured by the American Turret Lathe Company, Wilmington, Delaware. It is in the form of a well-illustrated pamphlet, showing the advantages of their "semi-automatic" turret lathes from the standpoint of the proprietor, the superintendent and the operator. The proprietor is interested in securing great output at low cost; the superintendent is chiefly interested in the "driving" power, which enables him to make a good showing, and in large output per man employed; while the operator desires a convenient machine which will enable him to make good wages without undue physical strain. These three views are really one, and the pamphlet is very successful in conveying the impression that these manufacturers have good ideas and that they have embodied them in their machines. They have no hesitation in guaranteeing what the lathes will do.

The Jeffrey Manufacturing Company, Columbus, O., have prepared a new and completed catalogue of chains which is ready for distribution and will be sent on request.

The Phosphor-Bronze Smelting Company, Limited, 2200 Washington Avenue, Philadelphia, have sent out their revised Phosphor-Bronze Price-List No. 17, which presents lists of the various forms of this metal which they are prepared to furnish.

"Some Words of Wisdom About Paint" is the title of a little pamphlet received from the Joseph Dixon Crucible Company, Jersey City, N. J. It is printed in the interests of the well-known graphite paint manufactured by this company and shows its qualifications as a protective covering for roofs.

The General Society of Mechanics and Tradesmen, 20 West 44th Street, New York, has added a new department to its library for current catalogues connected with machinery, building and machinery supplies of all kinds. The catalogues will be kept on file carefully indexed and made accessible at all times to those who may care to consult them. Machinery concerns are requested to send their catalogues to the librarian at the address given above.

The Springfield Gas Engines.—The Springfield Gas Engine Company, of Springfield, O., have issued a 32-page catalogue of their gas engines in which the designs are illustrated in detail by aid of half-tone engravings. Their unusual simplicity is strikingly shown. A number of illustrations of important plants employing these engines are included. The engravings are excellent and the pamphlet is adapted to the wants of busy men.

Hydraulic Tools.—Watson-Stillman Company have just issued another of their subdivided catalogues, No. 60, illustrating and describing hydraulic tools used by jewelers and die-sinkers. Each page contains an engraving of one of these machines and a carefully prepared description, together with a short table of weights, pressures and prices of that machine. This company makes a very large line of high-pressure hydraulic tools for all purposes and has exceptional facilities for the making of special tools and machinery.

The Knecht Brothers Company, Cincinnati, O., designers and builders of special machinery and tools, have prepared a pamphlet of eight pages describing their friction sensitive drill, which is considered an indispensable machine by those who use it. It is described in this pamphlet, dimensions and details of weight and capacity being given. In a number of testimonials we find letters from Mr. Howard M. Smith, Master Mechanic of the Terminal Railroad Association of St. Louis, and from Mr. H. A. Gillis, Superintendent of the Richmond Locomotive Works, commending it highly. Mr. Smith uses the machine as a centering machine as well as a drill press. We have already directed the attention of our readers to the design and construction of the machine in our pages.

Catalogue of the Niles Tool Works.—This book of 169 pages is the handsomest work of the kind we have seen. It is bound in flexible morocco and was prepared for distribution at the Paris Exposition. The descriptions are in French, English and German, the three languages being used in parallel throughout the book. The dimensions are given in metric and English measures. The machines are presented in the following groups: Railroad machinery, lathes, pulley, planing, slotting and shaping machines, boring and turning mills, horizontal boring and drilling machines, cylinder boring machines, drills and boiler shop tools. The engravings, which are remarkably fine, also include a number of views of some of the largest machine shops in the world in which the product of these works is used. The catalogue compels admiration in itself. It must convey an impression of the high character of the Niles Tool Works even to those who may not know of this in other ways, and none but a successful concern could produce such an exhibit of its work. As a piece of good printing and handsome, tasteful catalogue literature, it has not been equaled by any we have seen.

EQUIPMENT AND MANUFACTURING NOTES.

The Ajax Metal Company have secured the services of Mr. J. G. Miller to represent them in Chicago and the Northwest. His office is in the Marquette Building, Chicago.

The Rand Drill Company have received recognition from the Paris Exposition for the high character of their machinery in the form of the grand prize and gold medals.

Mr. Nat C. Dean informs us that he has severed his connection as representative of the Carbon Steel Company, but will continue his connection with the railway paint business of The Lowe Brothers Company.

The locomotives of the Chicago, Rock Island & Pacific and the Rio Grande Western railways, illustrated last month, were equipped with Ashton Muffler, pop safety valves furnished by the Ashton Valve Company, 271 Franklin Street, Boston.

Mr. J. W. Gardner has resigned as General Sales Agent of The Sargent Company, Chicago, to become associated with Mr. E. C. Darley, General Western Agent of the Aultman & Taylor Manufacturing Company, Mansfield, O., manufacturers of the Cahall vertical and Babcock & Wilcox water-tube boilers.

The Pressed Steel Car Company have received an order for 70 steel ore cars of 80,000 lbs. capacity for the Great Southern Railroad of Spain. This is the first use of steel cars in that country. They are to be of the type used in the United States, except that one car in each train, or seven cars in the lot, will have a timber shelter for the use of brakemen.

The Ashcroft Manufacturing Company, 87 Liberty Street, New York, have been informed that they have been awarded a medal at the Paris Exposition for locomotive steam gauges. In view of the fact that France is the home of M. Bourdon, the inventor of the Bourdon spring steam gauge, this is a high compliment to American enterprise.

The Richmond Locomotive and Machine Works have just received an order from the Intercolonial Railway of Canada for ten consolidation locomotives with 56-in. drivers; weight in working order, 164,000 lbs., with 147,000 lbs. on drivers. The boilers are of the straight-top type, 66 ins. in diameter at the smokebox end, and will carry 200 lbs. steam pressure. Five of the engines will be compounds, with 22½ and 35 by 30-in. cylinders.

Mr. C. H. Howard of Schickle, Harrison & Howard, St. Louis, has patented a new brake gear for railroad cars which is decidedly novel. It is an arrangement of a hollow cast-steel bolster into which are incorporated the air-brake cylinder and triple valve in such a way as to avoid the use of brake beams and all levers and the usual rods. Near each end of the bolster is a cylinder with two pistons, each piston being coupled to a brake shoe. The cylinders are between the wheels and the motion to the shoes is direct. It is an exceedingly ingenious arrangement.

A convention of salesmen of the Magnolia Metal Company, at which twenty-five gentlemen from all parts of the United States and Canada were present, was held at the Murray Hill Hotel, New York, on the 6th to the 10th of September, and subjects appertaining to the sale of Magnolia Metal were discussed, the greatest interest in the business of the company being manifested. Reports for all concerned showed that the business had never, during the past fifteen years, been so prosperous as during the last year and a half, and that the prospects for the future are far better than ever before. The utmost enthusiasm was shown by all for Magnolia Metal and for the future of the company and the affair wound up by the presentation of a loving cup to Mr. E. C. Miller, Vice-President and General Manager.

The Babcock & Wilcox boilers have been awarded the "Grand Prix" at the Paris Exposition. This is a pleasing recognition of the merits of the products of this firm, and a satisfactory support of the principle of water-tube boilers.

Among the awards announced at the Paris Exposition is that on pneumatic tools, bestowed on the Chicago Pneumatic Tool Company in the form of a gold medal, the highest and, so far as appears from the printed reports, the only award made on this class of machinery. In addition to this gold medal, Mr. Joseph Boyer, of St. Louis, the inventor of the Boyer Pneumatic Hammer, Boyer Pneumatic Drill and other tools made by this company, was also given a gold medal. There were several competitors striving for this prize and the recipients of the honors feel highly gratified at the result.

In a recent communication to the Bullock Electric Manufacturing Company, Messrs. Geo. A. Fuller Company, contractors for the Broadway Chambers Building, New York City, a model of which is exhibited at the Paris Exposition, say: "Your dynamo forms a prominent feature in our exhibit, and helped to obtain the grand prize and gold medals which have been awarded to this exhibit." Prospective purchasers would serve their own interests by investigating the Bullock dynamos and motors before placing their orders. Descriptive and illustrated bulletins furnished free upon request to the Bullock Electric Manufacturing Company, St. Paul Building, New York City.

Prominent among the representative machinery concerns of the country who have carried off high honors at the Paris Exposition is the Shaw Electric Crane Company of Muskegon, Michigan, manufacturers of the celebrated Shaw three-motor electric traveling cranes, for machine and railroad ships, shipbuilders' and boiler makers' use. Word has just been received by Messrs. Manning, Maxwell & Moore, the sole sales agents of the Shaw Electric Crane Company, that the International Jury of Award has awarded the Shaw Electric Crane Company a gold medal in Class 21, General Mechanical Apparatus, and a silver medal in Class 23, Electrical Appliances for Hoisting. The awards show a gratifying recognition of the superior merit of the Shaw cranes and bespeak an increased demand for them abroad.

The recent discovery of Goldschmidt, that aluminum in powder form is one of the most powerful reducing agents known, has attracted widespread attention. It is possible by this means to reduce the most refractory oxides and produce such metals as chromium, tungsten, molybdenum, manganese and nickel, perfectly free from carbon and in the fused state. This is possible because of the enormous heat produced by the chemical reaction of the aluminum upon the various oxides. The heat so produced is estimated at about 5,000 deg. and can be equalled only in an electric furnace. With considerable interest we learn that the Ajax Metal Company, of Philadelphia, have acquired a similar process for producing the alloys of these metals with iron, and so low in carbon and silicon as to meet all the requirements of steel makers, but of a far more inexpensive re-agent. Ordinary carbon steel castings can be made by this process in the crucible or on the open hearth. The castings so produced are so low in carbon as to almost approach malleable iron and require no annealing. The Ajax Metal Company intends to manufacture these alloys in ingot form for the use of tool-steel makers and manufacturers of armor plates, projectiles, etc., also to manufacture chrome, nickel and ordinary steel castings of superior quality.

Naturally the competition for recognition of merit at the Paris Exposition is attracting a great deal of attention and the large number of awards granted to Americans is pleasing. The Department of Civil Engineering and Transportation has awarded the grand prize for the convertible open and closed car to the J. G. Brill Company, of Philadelphia. This company also received the grand prize for their complete system of electric trucks. These manufacturers are so well known in this country for the high character of their work that the award is not surprising, but it is encouraging to note the growing appreciation in foreign countries. The convertible car built by the Brill Company for the Leeds Corporation Tramways, which was exhibited at the International Tramway and Light Railway Exhibition in London last June, was considered the most complete and satisfactory convertible car ever built.

The Burlington's new line between Alliance, Neb., and Brush, Colo., was formally opened to general traffic September 15th. The new branch is 149.69 miles long, and is laid with 85-pound steel rails. It will make a short route between Denver and the rich mining districts of South Dakota and Montana. The new line connects with the system's Guernsey extension at Northport, Neb., and practically opens up a new transcontinental railway between Colorado and points in Montana, Washington and the North Pacific Coast. Under previously existing conditions the Burlington's traffic between Denver and the Black Hills was handled by way of Lincoln. The new cut-off will reduce the present distance 673 miles. A passenger is now able to leave Deadwood in the morning and reach Denver the same night. The new line will be of marked importance to the lumber and shingle interests of the Puget Sound district, as it will open up a new market. This trade is now to a great extent shut off from the Colorado markets because of the long haul.

In the rough and wild, yet picturesque, country of northern New Hampshire known as the White Mountain Region, one finds a wonderful array of scenic splendor, the like of which tourists say cannot be equaled elsewhere.

In this region, which is made up of several distinct mountain ranges, is the noted Franconia Notch and mountains. The principal feature is the profile of the "Old Man of the Mountains." Close by are Profile and Echo Lakes, Cannon Mountain, The Basin, Pool and Flume, each of which one finds to be highly interesting places. Bethlehem and Maplewood are delightfully located, and to them many go in search of a relief for hay fever, which is most always instantly alleviated, for the air is pure, dry and healthful.

Fabyan, Mt. Pleasant, Crawford, Jefferson, Lisbon, Sugar Hill, Colebrook, Lancaster, Ossipee, Bartlett, North Conway, Intervale, North Woodstock and other well-known resorts are the abiding places for thousands of tourists, at each of which places one finds an endless variety of mountain wonders.

Every tourist should visit Mt. Washington, for from that point one gets a complete view and idea of the mountain regions. The trip up the mountain is decidedly interesting. The summit is 6,293 ft. above the sea level, and in some places on the railroad the grade is 14 in. in every 3 ft. From the summit the view is magnificent, in some directions extending more than a hundred miles.

Short trips can be made from the summit. The one to the "Lake of the Clouds" giving one a taste of mountain climbing, while the excursion to Tuckerman's Ravine oftentimes proves to be hazardous and dangerous. The sunrise from Mt. Washington is a most beautiful sight and well worth the journey up the mountain to see.

Beginning September 15th the Boston & Maine Railroad placed on sale at many of its stations reduced rate tickets to the mountains good going not after October 6th (except from stations on Connecticut & Passumpsic and Fitchburg Divisions, sale being discontinued on September 29th). The rate is exceptionally low and if you want to go into the mountain regions under most favorable circumstances send to the General Passenger Department, Boston & Maine Railroad, Boston, for circular of White Mountain Trips.

WANTED.—Two complete volumes of the "American Engineer and Railroad Journal" for 1898, unbound. Will pay $3 each if in good order. Also copies of the "National Car and Locomotive Builder," one of the January and February issues of 1893. Fifty cents will be paid for a complete copy of each. Address L. L. S. and H. B. H., care Editor "American Engineer," 140 Nassau Street, New York.

AMERICAN ENGINEER AND RAILROAD JOURNAL.

NOVEMBER, 1900.

CONTENTS.

PERFORMANCE OF "NORTHWESTERN" TYPE LOCOMOTIVES.

Chicago & Northwestern Railway.

Built By The Schenectady Locomotive Works.

These locomotives, which have been described in the September and October issues of this journal, have given an excellent account of themselves in service. Both Mr. Quayle and Mr. Henderson speak in the highest terms of their performances. The writer received every courtesy from them in examining their operation on the road, and is convinced that this design is a decided step in the right direction. When a fireman of such large engines, on exceedingly hard runs, requiring at times the consumption of 9 tons of coal in three hours, voluntarily says that these engines are the "easiest he ever fired," the design may be accepted as successful. In firing, with ordinary care, there is no black smoke from the stack, and very few sparks. The strongest exhaust does not tear the fire, and the steaming qualities with "run of mine" Illinois coal are perfectly satisfactory. The writer saw one of these engines start a heavy train of about 450 tons, and, with the reverse lever in full gear, force it to a speed of 40 miles per hour without tearing the fire or running the steam pressure down. He also saw one of them haul a heavy train 32 miles in one hour, making six stops, the running cut-off being half stroke, with the safety valve blowing at intervals all of the way. The ability to sustain the power is remarkable, and the engines are continually surprising the men who run them.

Engine No. 1,017, the one which made the record on the New York Central, published last month, was given a very severe trial on the "Colorado Special" train No. 5 on the Chicago & Northwestern, October 16. This train leaves Wells street station, Chicago, at 10 a. m., and is due at Clinton, Ia., 138 miles at 1.20 p.m. The regular train has seven cars, a mail car, a buffet car, sleeping car, dining car, chair car and two passenger cars. On the trip in question, however, there were three extra passenger and one chair car added, for the purpose of ascertaining the capacity of the engine in maintaining high continuous horse-power.

The grade of the road is shown by the profile, which is reproduced. The regular schedule shows eight station stops, but in addition to this, there is the draw-bridge at the Mississippi River and the C., B. & Q. Railroad crossing between the river and Clinton station. In addition to this the train was compelled to stop at another station on account of meeting another passenger train stopping at the station, so that on the day in question the run was made with eleven actual stops between the terminals of the division; partly due to this and other causes, the train at one point was as much as seven or eight minutes behind schedule time, but as will be seen on the diagram, reached Clinton one minute ahead of time.

The profile is seen to be a continuous rise up to Malta, which is about one-half way over the division, from which point there is a general descent with a number of short up grades. As the run was not intended to be one demonstrating "fuel economy" but to illustrate the capacity of the engine, the efforts were made to keep the engine up to the maximum at practically the whole distance, and, as might be expected, the fuel consumption of nine tons for this trip was rather large. This is accounted for by the fact that the locomotive worked on an average of 10 ins. cut-off over the entire division, and the average horse-power was between eleven and thirteen hundred for almost the entire trip. The maximum horse-power was reached on practically level track, and shown by diagram No. 18 to be 1,507. For this card the speed was 50 miles an hour and the cut-off 12 ins. Between Ashton and Nachusa a speed of from 60 to 70 miles was maintained with a cut-off averaging 10 ins. and a horse power of nearly 1,300. It should be stated that these diagrams were taken during the ordinary operation of the engine on its trip and that there was no pretense made of dropping the lever to obtain any particular diagrams, and that these conditions were maintained continually, as far as possible, throughout the trip.

One injector (a No. 19 Monitor) was kept at work continually, and a greater part of the time the second injector was used to about one-half its capacity. The statement of nine tons of coal for the trip is probably not entirely correct, but will give a fair idea of the economy of the engine as a prime mover. Allowing 1,250 indicated horse-power as an average on the trip of three and one-third hours' duration, the consumption of coal was 4.3 lbs. per indicated horse-power per hour, which is very fair for a locomotive worked as severely as this one was on the run in question. It will be noticed by the diagrams that there was no great difficulty in keeping up steam, although it goes without saying that to handle that amount of coal in the time mentioned, the fireman was kept busy.

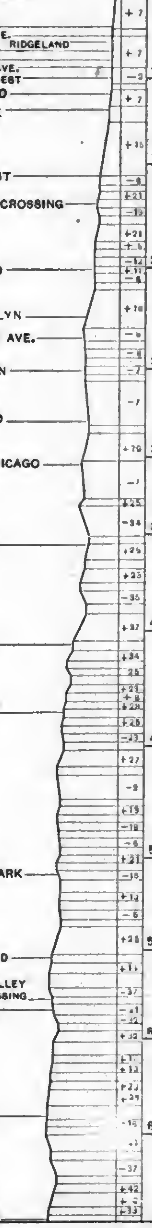
Numbers corresponding to the indicator cards, that are not produced on the lower part of the sheet, indicate that they have been omitted as they were almost identical with others taken under similar conditions, and for this reason have not been drawn. The principal dimensions of the engine have already been stated in our columns, but we can now add that the exhaust nozzle in this case was 5 ins. in diameter, and that the fuel used was ordinary Illinois coal.

The weights of the cars given in the table are those taken empty, so that considering the baggage, mail and the passengers there would be about 450 tons back of the tender. If five minutes are allowed for each stop, which is pretty close to the time lost in making the stop and regaining a high speed afterward, it will be seen that the average running time of this train was 55 miles an hour between stations, and the speeds given at the time the diagrams were taken show that this was maintained on an average, and often exceeded, throughout the trip.

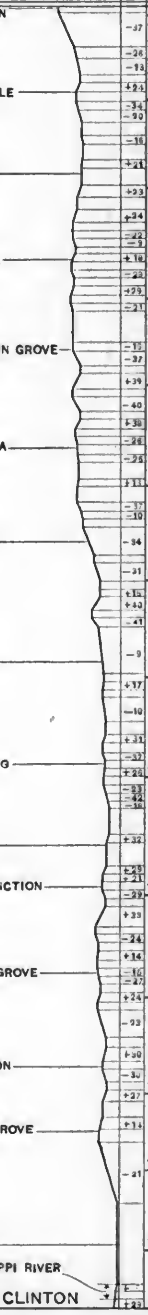
These figures for horse-power may have been exceeded in locomotive practice, but for long-sustained power we have no record as good as this for a soft coal burning engine, and in such severe service. It is a remarkable performance.

The cards exhibited in the three series, A, B and C, on page 336, were taken on this run, but with an ordinary train. Series A represents the effect upon the horse-power of increasing

Profile of the C. & N. W. Railway.—Chicago to Clinton.



Station	Miles from Chicago	Number of Indicator Card	Time	Speed in Miles per Hour	Cut-off Notches from Center	Cut-off in Inches	Indicated Horse Power
CHICAGO							
OAKLEY AVE.		1	10:05	25	11	15"	807
			10.08				
WEST 40TH ST.	5	2	10:10	19	13	17"	695
			10:13½				
		3	10:15	50	5	9¾"	1129
AUSTIN							
AUSTIN AVE.							
AVENUE							
RIDGELAND							
OAK PARK			10:18				
LATHROP AVE.							
RIVER FOREST	10						
MAYWOOD		4	10:21	50	5	9¾"	1065
MELROSE							
	15						
ELMHURST			10:27½				
I.C. R'Y CROSSING							
LOMBARD	20						
GLEN ELLYN							
COLLEGE AVE.							
WHEATON	25		10:40				
WINFIELD		5	10:45	53	6	10¾"	1213
WEST CHICAGO	30		10:49½				
		6	10:54	50	6	10¾"	1234
	35	7	10:58	—	—	—	—
GENEVA			10:59½				
		8	11:04	30	6	10¾"	1256
	40	9	11:08	50	7	11¼"	1331
LA FOX			11:09				
ELBURN							
	45						
		10	11:18	58	6	10¾"	1275
	50						
MAPLE PARK			11:21				
		11	11:22	60	5	9¾"	1137
	55						
CORTLAND			11:26				
SPRING VALLEY CROSSING							
DE KALB			11:32				
	60						
MALTA			11:41				
	65						
		13	11:43	—	—	—	—
		14	11:45	70	4	6½"	1165
CRESTON			11:46½				



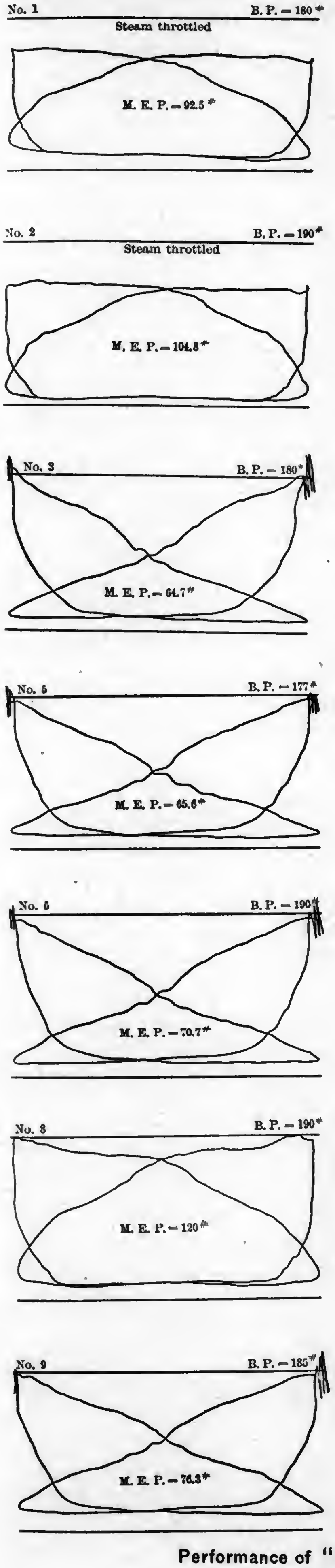
Station	Miles from Chicago	Number of Indicator Card	Time	Speed in Miles per Hour	Cut-off Notches from Center	Cut-off in Inches	Indicated Horse Power
CRESTON	70						
		15	11:46	70	4	8½"	1055
			11:53½				
ROCHELLE	75	16	11:55	—	CORNER	21"	—
FLAGG	80						
		17	P. M. 12:04	40	8	12"	1383
		18	12:06	50	8	12"	1507
ASHTON			12:08				
	85	19	12:10	60	6	10¾"	1325
		20	12:12	60	6	10¾"	1265
FRANKLIN GROVE							
	90	21	12:14	70	5	9¾"	1258
		22	12:16	70	5	9¾"	1197
NACHUSA							
		23	12:19	70	6	10¾"	1348
	95						
DIXON			12:25				
	100						
		24	12:31	50	7	11¼"	1197
NELSON	105	25	12:34	65	6	10¾"	1195
		26	12:36	68	6	10¾"	1197
STERLING	110		12:40½				
		27	12:44	50	6	10¾"	1195
GALT							
R. I. JUNCTION	115						
		28	12:50	60	7	11¼"	1434
ROUND GROVE		29	12:54	60	5	9¾"	1114
	120						
		30	12:56	60	5	9¾"	1001
		31	12:58	70	5	9¾"	1131
			12:59				
MORRISON		32	1:00	—	21	21"	—
	125						
UNION GROVE			1:05				
		33	1:06	50	7	11¼"	1140
	130	34	1:08	60	6	10¾"	1116
		35	1:10	70	6	10¾"	1116
		36	1:11	70	7	11¼"	1075
FULTON	135		1:12½				
MISSISSIPPI RIVER BRIDGE		37	1:15	45	10	14"	1160
CLINTON			1:19				

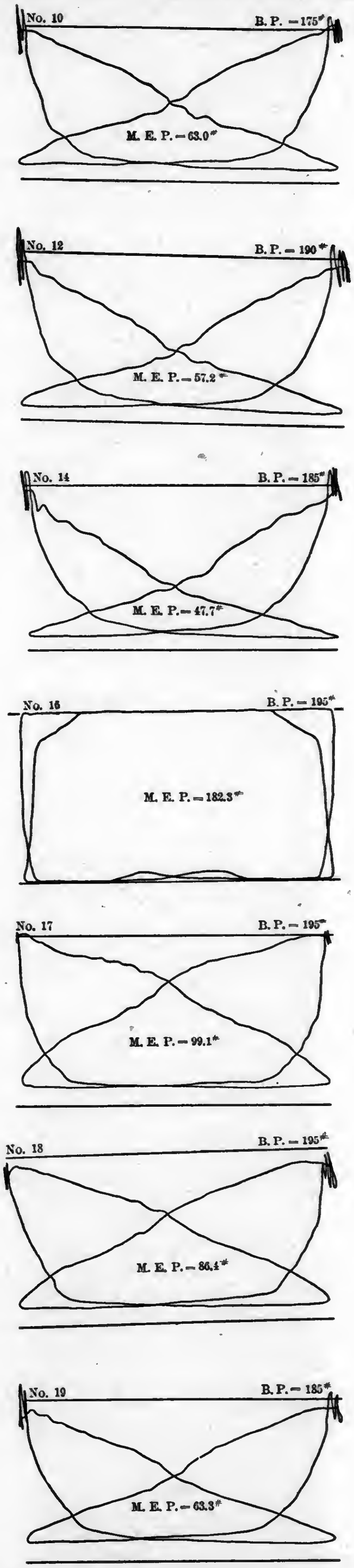
A.E.

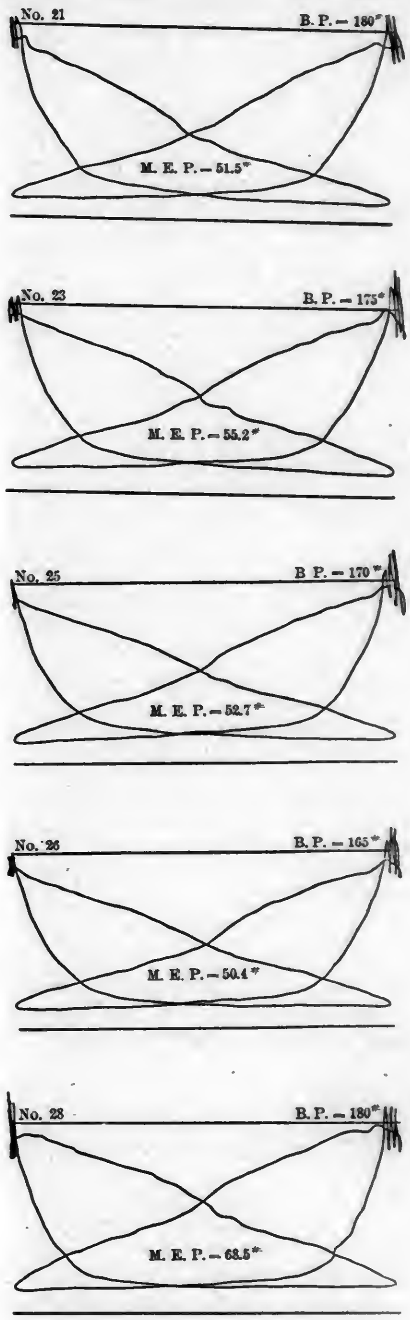
Performance of "Northwestern" Type Locomotives—Chicago & Northwestern Railway.
Record Showing Sustained High Horse-Power for a Run of 138 Miles.

the cut-off without varying the speed, which, in this case, was 50 miles per hour. It will be seen that the horse-power increased from 784 to 1,063 with essentially the same boiler pressure and the throttle wide open. The reverse lever was moved to increase the cut-off by 1 in. at a time. Series B carried out the same plan but with a less uniform speed, the cut-off varying from 8⅛ to 11¾ ins., and the horse-power from 1,007 to 1,296. In series C, showing three cards taken at three-minute intervals, the speed rose from 48 to 70 miles per hour. The last card was taken at 11¾-in. cut-off and at 70 miles per hour. This power was sustained about 10 minutes, but the fireman believed that he could have kept it up for the entire trip without exceeding his own capacity or that of the boiler. This train weighed about 350 tons and made the 10 stops already referred to, doing the 138 miles in 3 hours and 25 minutes.

This engine also rides remarkably well. There was no rolling and very little jerky motion. How much of this is due to the outside journals on the trailing wheels and how much to the long leaf springs over the trailer boxes we do not know, but it has been demonstrated that easy riding may be obtained, and it is certainly worth a great deal of trouble to secure this result, even if it is at the expense of some additional weight and complication.





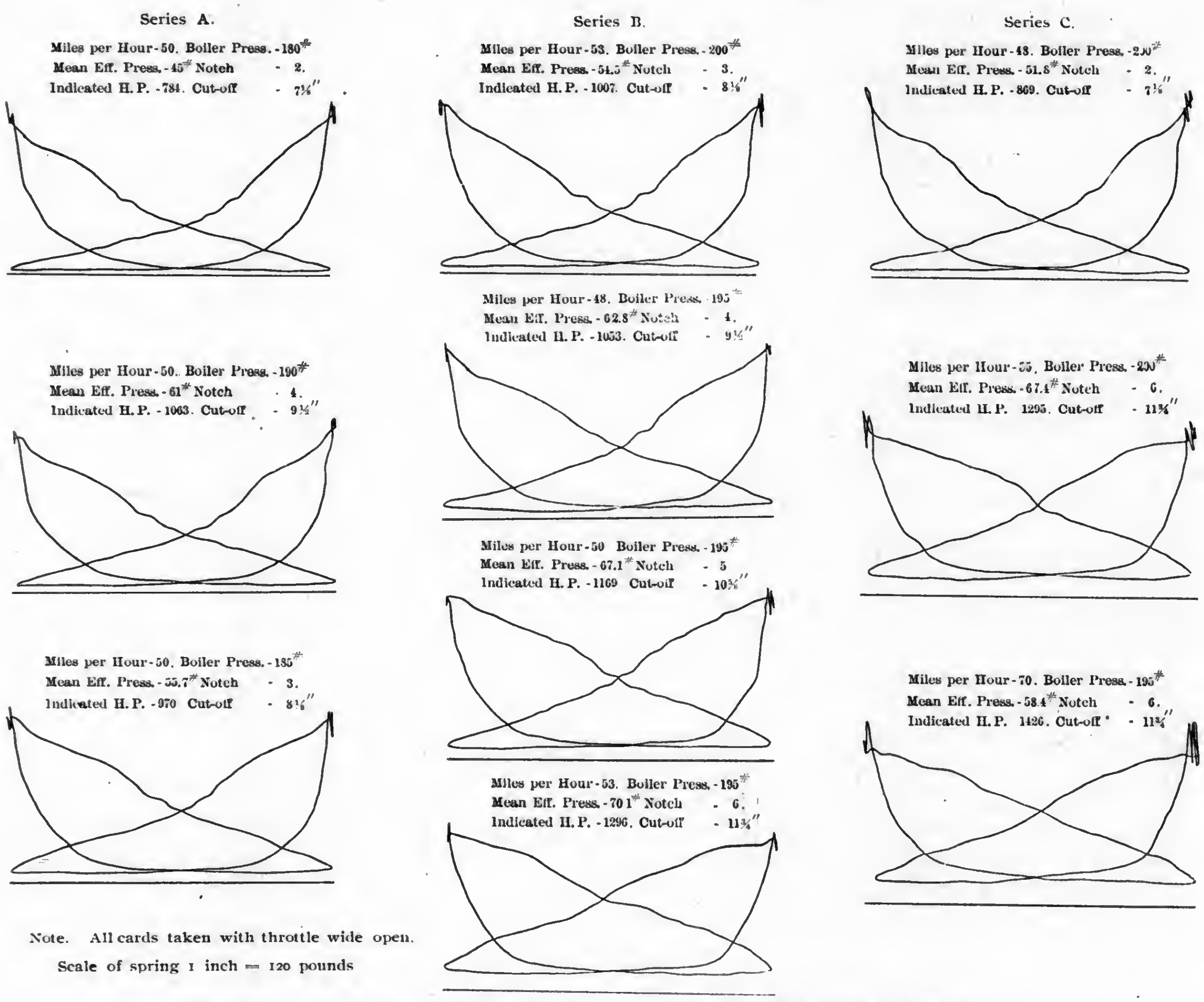


Note: All cards but No's. 1 and 2 were taken with throttle wide open.
Scale 1 inch—120 pounds.

Composition of Train.	
Style of Car	**Weight. (tons)**
Mail	32
Sleeper "Marcellus"	62
Dining	48
Chair	36
Passenger	37½
Passenger	37½
Passenger	37½
Passenger	37½
Chair	37
Passenger	29
Buffet	48
Total	442

A. B.

Performance of "Northwestern" Type Locomotives—Chicago & Northwestern Railway.
Indicator Cards Corresponding with Record on Page 334.



Performance of "Northwestern" Type Locomotive—Chicago & Northwestern Railway.
Cards Showing Variation of Power and Speed.

The performance sheets show a decided advantage of the wide firebox combined with piston valves and an able boiler, the records of these engines being approximately 20 per cent. better than those of the heavy 8-wheel engines on this road. The fire does not move with the heaviest exhausts, run-of-mine coal is satisfactorily used with very little smoke and few sparks, the two fire doors seem to please the fireman, and the entire design has thus far proved to be all that was expected or desired by the operating as well as the motive power officers.

Steel rails of the prevailing large sections are well known to be inferior in wearing qualities to those of lighter section of some years ago. Captain R. W. Hunt, in his paper before the American Society of Civil Engineers, reminds us that the heavier sections receive less work in the rolls and they are also finished at a higher temperature than smaller sections. In his judgment it is desirable to give the rail its finishing passes after it has cooled slightly. Captain Hunt speaks highly of the McKenna process of re-rolling old rails. Re-rolled rails promise to give better wear than new ones of heavier sections. Five years' experience and the use of 100,000 tons of these rails on large roads supported this opinion. "One chief engineer, on whose road there are many of these rails, says: 'No rail ought to be used at all until after it has been renewed.'" The most desirable effect secured by this process is that produced by finishing the rolling at low temperatures.

Coal consumption for gas engines operating with producer gas is stated in a series of articles in "Engineering" to be from 1.1 to 1.6 lbs. (anthracite) per brake horse-power. In 12 plants, including 28 gas engines aggregating 2,905 horse-power, the figures fell within the limits stated. Another group of 10 engines operating with producer gas and aggregating 824 indicated horse-power consumed 1.16 lbs. of anthracite per indicated horse-power hour, and in another case 9 engines averaged 1.27 lbs. of anthracite per brake hourse-power per hour.

In an interesting comparison of the economy of stationary and locomotive steam plants the "Railroad Gazette" shows, when one of each type of about 1,000 horse-power are considered, that the locomotive stands remarkably well. Of course the advantage in fuel economy per unit of work is with the stationary plant. A locomotive cannot be expected to do much better than 4 to 7 lbs. of coal per horse-power per hour, while a simple non-condensing stationary plant will use about 3 or 5 lbs. But when the interest charges on the first cost are considered the advantage of the stationary plant dwindles, and when all sources of expense are included the difference in the cost of power delivered by the compound locomotive used by a triple-expansion condensing engine is surprisingly small.

WHAT MOTIVE POWER OFFICERS CONSIDER IMPORTANT.

As Indicated in a Number of Interviews.

When given the opportunity men usually indicate the direction of their thought by the subjects they like to talk about. The following paragraphs reflect for our readers the impressions gained by our representative in recent interviews with a dozen of the most progressive motive power officers by the subjects which they voluntarily introduced.

Without doubt firebox design is now the leading subject with motive power men. Wide fireboxes for soft coal burning engines are coming into use very rapidly, and judging from the number of them springing up in all directions the change may appear to be sudden. It really is not so, for the necessity for the change was appreciated long ago, and it only remained for the movement to start in order to become general. The good work has as yet only begun, and it is now necessary to find the proper size of grates for the special condition existing on each road. We shall soon see the grate made to fit the coal, but this question is secondary in importance to that of the initial step of getting the mud rings out beyond the frames and it will need to be carefully studied for each individual case. From recent developments it is clear that grate areas should not be proportioned to heating surface or to cylinder volume, but that they should be made to suit the coal and the demands made upon the fire. An appropriate illustration of this proved that coal may be too good, or that a firebox designed for low grade or slack coal is not the thing for high grade lump. Several invited guests were to watch the performance of one of the newest wide firebox engines designed to burn slack. The designer of the engine discovered to his dismay that the engine had accidentally received a tank of the best of soft coal in large lumps for the exhibition run and even with the most skillful handling the steam at once ran down to 100 lbs. However, at the bottom of the pile was a lot of slack which had been left on the tender from the previous run, and when this was reached the engine steamed beautifully, retrieving the reputations of all concerned. The grate was twice too large for the lump coal and even when it was broken up the steam failed. Grates should be large enough to burn enough of the poorest coal to make steam for the hardest work of the engine, and if it is occasionally necessary to burn better or different coal the area should be adjusted by blocking off a portion of the grates. This applies to hard as well as soft coal. The combustion space thus provided at the front end of the firebox is the best kind of combustion chamber and the space is generally more necessary with the better qualities of fuel than with the cheaper grades. It will probably be found necessary to provide for this adjustment in the design of grates.

Larger tenders are the rule on a number of roads. The Lehigh Valley has adopted 7,000 gallon tanks for freight engines and 6,000 for passenger. In seeking the reasons we are told that greater capacity in tenders is "everybody's game," in the sense that there are no objections. They would naturally increase in size to keep pace with the locomotive, but there are other reasons, in the reduction in the number of stops for water, the desire in many cases to avoid taking water from certain undesirable sources and the saving of the general destruction wrought by the savage emergency brake applications which seem to be necessary in order to stop trains so that the manhole of the tank is opposite the water column. In freight service, tank stops are particularly destructive, often causing trains to break in two. The sudden shocks due to the emergency applications of the brakes in order to stop at the right spot are also severe upon the draft rigging which is not actually broken. When traffic is heavy enough the track tank gives the ideal method of taking water, but these are not sufficiently common to avoid the necessity for large tenders. The desire to aid the fireman by an intelligent arrangement of sloping sides of coal spaces is noticeable. Many recent designs have carried this feature farther than was customary a year or so ago. Sloping sides are not new, but of late the slant and position of the slopes have been greatly improved so that the coal will be sure to slide and save a few steps. Unless these matters are carefully attended to, firemen are justified in protesting against the tendency toward very large engines.

The whole question of water service for locomotives is opened up by the enlargement of tenders and a most important improvement in the delivering capacity of stand-pipes and tank cranes is seen to be necessary. It is time to consider the general introduction of 12-in. pipes with cranes and stand-pipes of corresponding capacity. The Chicago & Alton, Chicago & Northwestern and other lines in the Middle West show their appreciation of quick delivery of water, but many roads exhibit a strange neglect of this. The writer watched the painful process of taking water on one very fine train for eleven minutes, and the train was late, when one minute is enough where the facilities are what they should be. These delays contribute to the necessity for heavier engines and motive power men should see to it that this fact is understood. In their own defence they should take it up and vigorously.

Boiler design with a view of meeting the requirements of high steam pressures and the evident tendency to increase them is looked upon with not a little concern by those who have given most attention to the study of staybolt breakages. During the last few years the shapes of fireboxes have been greatly improved in the direction of avoiding sudden changes of curvature of the side sheets. This is true of narrow as well as wide fireboxes, and it is now customary to give easy and uniform curvature to the side sheets of wide fireboxes and to make the enlargements from the water legs of narrow fireboxes as gradual as possible. These changes of form have proven their desirability, but something more seems to be needed. One of the possibilities of the future is the use of specially prepared copper as a material for staybolts. Copper has been "treated" to give it a tensile strength between 45,000 and 50,000 lbs., and if its ability to withstand frequent bendings is not impaired it may again become a factor in boiler construction. We hope to give our readers information on this subject after seeing the results of promised developments.

Water pipes for cooling locomotive and tender bearings have been abolished on the Lehigh Valley, and without an increase of the number of delays due to hot boxes. These pipes were originally applied for the purpose of cooling hot bearings while trains were standing at stations, but the enginemen soon extended their use and continued the streams of water while running, until the number of cut journals became troublesome. The water was so easily turned on as to tempt the men to use it too freely, and in a way not intended and to neglect the proper methods of lubrication. When the pipes were taken off no new devices were put on, but the bearings were merely kept in good condition, the inspection was made more severe and special care was taken to maintain the waste in the cellars and boxes, so that it would properly fulfil its functions. It is interesting to know that the remedy for hot bearings is so simple.

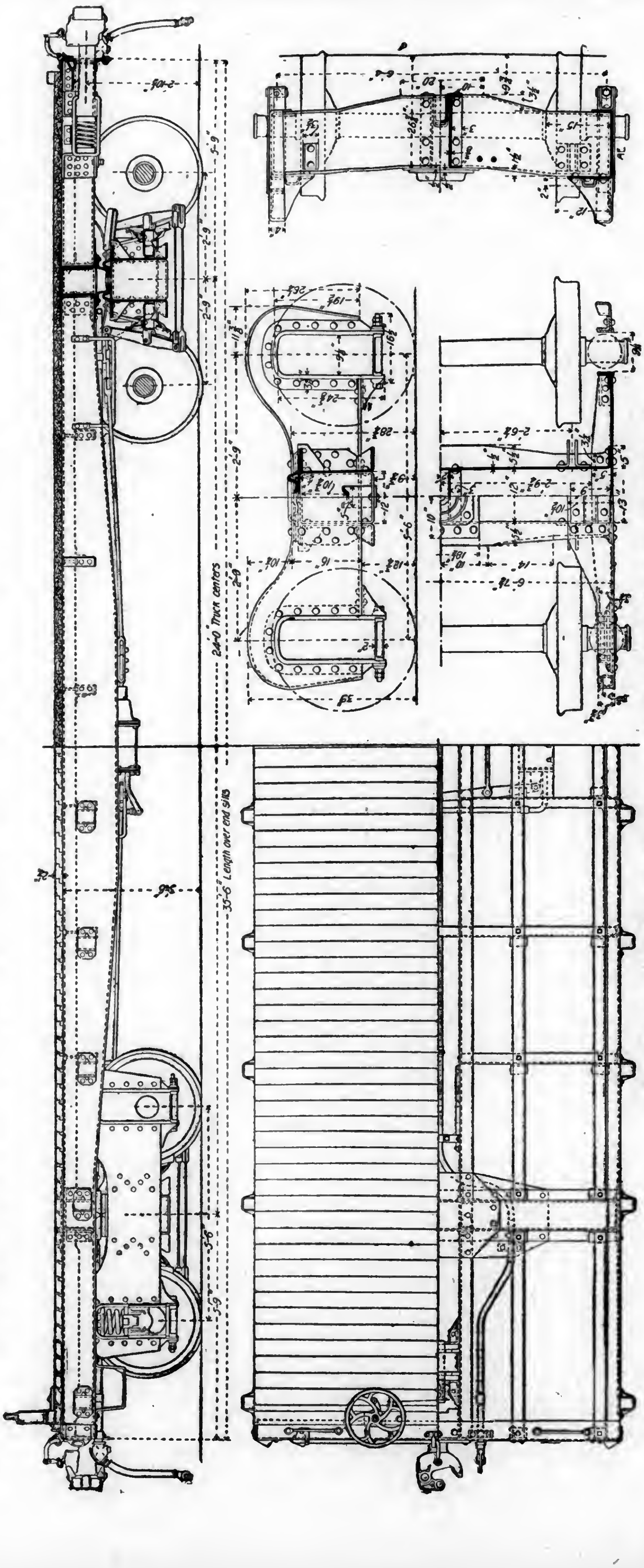
Methods of handling work in erecting shops have changed in a number of shops visited. Formerly an erecting gang of four or five men and a foreman did all of the work on a certain number of engines. They stripped the engine upon its arrival in the shop, distributed the parts for cleaning and repairs, reassembled them and finally put them together on the engine. Now the stripping and all work not requiring attention from machinists and relatively high-priced men is done by a stripping gang who take down, distribute, and finally asemble the parts for replacement. These men work under a foreman, and they relieve the regular erecting gangs of all the work which may be entrusted to relatively unskilled labor. The effect upon the men is to develop a rather unexpected amount of intelligence among them which seems likely to lead to a

recruiting source for the erecting gangs. In the new shops of the Buffalo, Rochester & Pittsburgh Mr. Turner expects to use two such gangs, and they will be essentially "crane gangs," the foreman being in charge of the cranes. There they will also raise engines to take out and replace driving wheels and trucks. The foreman will be expected to keep track of the location of every part removed from each engine he works on and in this way he will be a valuable assistant to the general foreman.

How to improve the passenger-car truck is one of the questions of the day. It can not be taken up too quickly or too thoroughly in view of the present tendency toward increasing the weight of passenger cars. A weight of 125,000 lbs. in a new Pullman car is not at all encouraging to those who are doing their utmost to furnish power enough to keep fast trains up to schedule. This weight question is becoming serious, and such an increase for which there can be no justification will probably call out the most vigorous of protests not only from mechanical officers, but general managers as well. A material saving of weight may be secured by improved truck design, and the truck is an excellent beginning for a study of the elimination of unnecessary weight in passenger equipment. Those who are working on this problem realize the influence of great weight of cars upon smooth riding, and they are beginning to examine the possibilities of securing the same result by improved spring suspension. We notice a tendency to question the value of the equalizer in the construction of four-wheel trucks, and it will not be surprising if a design of truck of this type should appear under a heavy car, with 5 by 9-in. journals, and elliptic springs over the journal boxes. As at present constructed the coil springs over equalizers are extremely short, and they are placed quite a distance from the journals. This does not seem to be a favorable arrangement for smooth running, and it brings up the question whether the equalizer is necessary on the smooth tracks of the present day. Doubts of this are expressed by men who are in a position to demonstrate the facts, and there is good reason to expect interesting developments. It is important to know whether the smooth-riding qualities of the heavy Pullman car cannot be obtained in a combination of a lighter car and improved spring rigging. In a list of Pullman cars on the Burlington road there are five weighing 124,000 lbs. each and four weighing 120,000 lbs. each. Other roads have, perhaps, as many. What this means will be clearly understood if these nine cars should happen to be put in the same train. It would weigh 550 tons behind the tender, without baggage, mail or express cars. These weights have apparently increased to the extent mentioned without having attracted much attention.

(To be continued.)

The Lake Shore & Michigan Southern has ordered 80 steel ballast cars of 100,000 pounds capacity from the Pressed Steel Car Co.



Steel Flat Cars, 100,000 Pounds Capacity.—New York Central & Hudson River Railroad.
Built by The Pressed Steel Car Company.

STEEL FLAT CARS, 100,000 POUNDS CAPACITY.

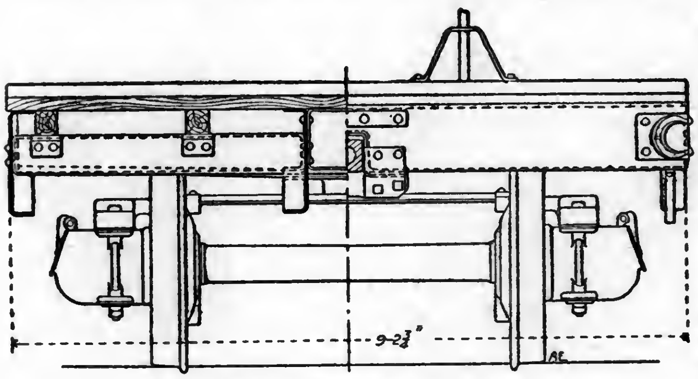
New York Central & Hudson River Railroad.

Pressed Steel Car Company, Builders.

This road has found flat cars of 50 tons capacity very convenient in shipping heavy machinery, narrow-gauge locomotives and other heavy objects which cannot be conveniently loaded into box or gondola cars. About two years ago 10 steel cars were built and the demand for them has necessitated the building of 10 more of this capacity. The accompanying engravings illustrate the construction and indicate the design of the underframing and the manner of securing the wooden decking. The cars were built by the Pressed Steel Car Company, using pressed steel parts exclusively, except for the plank deck and stringers. They were built to the following general dimensions:

Length over end sills	35 ft. 6 in.
Width over stake pockets	10 ft.
Width over side sills	9 ft. 2¾ in.
Width over wooden floor	9 ft. 4¾ in.
Height, top of rail to floor	3 ft. 8¼ in.
Height over brake shaft	6 ft. 3 in.
Height to tops of center channels	3 ft. 6 in.
Height to bottom faces of center channels at bolster	2 ft. 8 in.
Distance between truck centers	24 ft.
Trucks, wheel base	5 ft. 6 in.
Trucks, centers of journals	6 ft. 4 in.

Four longitudinal pressed-steel channels carry the load. These are 10 ins. deep at the ends and from the inside faces



Half Section and End View.

of the body bolsters they begin to deepen, reaching a depth of 17 ins. for a length of about 7 ft. at the center. The outside sills are continuous and the center sills are cut at the body bolsters to let those members through. The cross members are pressed-steel channels 7 ins. deep and 4 ft. long secured between the webs of the center and side sills. There are 12 of these members, upon the upper flanges of which six oak stringers are carried. These extend the full length of the car; the outside and intermediate stringers are 3½ by 4 ins. and the two at the center at 3½ by 2 9/16 ins. The decking, which is of 2¼-in. oak, is secured by spiking to these. The construction of the bolsters and end sills is clearly indicated in the engravings.

The cars have Fox pressed-steel tracks, 33-in. wheels weighing 650 lbs. each and open-hearth steel axles with 5 by 9-in. burnished journals. Eight-inch double coil springs are used in the trucks, which are equipped with McCord journal boxes, Harrison dust guards and National hollow brake beams. The draft gear is attached to the webs of the large center channels. It has two twin springs and 21¾-in. follower plates at each end. The cars are fitted with Gould couplers and spring buffers. They weigh, empty, 28,400 lbs., this being the average weight of 8 cars.

We are indebted to Mr. A. M. Waitt, Superintendent of Motive Power, for the drawings from which our engravings were prepared.

HARD, TOUGH STEEL BEST FOR RAILS.

P. H. Dudley has put his long experience in connection with steel rail practice into an elaborate paper read before the International Railway Congress. The principles elucidated by track inspection covering a number of years had been reduced to practice in the form of hard steel and stiff rail sections. These, the author says, have reduced the resistance of trains one-half since 1880, and the advantage is shown in the fact that one locomotive has drawn a train of 16 cars weighing 1,840,000 lbs. at a speed of 60 miles per hour. Soft steel would never have permitted such progress. The study of rails had reached a point permitting the design of rails for certain requirements as definitely as that of the design of locomotives of a stated capacity. The researches of this authority are summarized in the following conclusions, which are quoted from the paper:

As the permanent way becomes physically weak for the increasing traffic, more labor must be employed in its care and repairs to the equipment.

When the permanent way is made physically strong by stiff and smooth rails, less labor is required for its care and repairs to the equipment, and all the operating and maintenance expenses decrease.

When stiff and heavy rails are used, unless made of a high grade steel and proper width of head, the loss of metal will be faster for a given traffic than on weak and light rails.

On stiff rails the deflections in distributing the wheel load to the ties are much less, the area of contact between wheel and rail is reduced, therefore the intensity of pressure is greater per square inch of contact than on the lighter rails. The intensity of pressure of the wheel loads transferred to the ties, ballast and roadbed is reduced and this is the main economic feature of heavy rails.

The stiff rails in distributing the wheel loads over a larger area of roadbed increase the stability of the track, save labor, ties and roadbed by transferring from them the destructive work to the metal of the rail head, for which provision can be made. This will now require attention and study by the railroad companies. Too little care has been given to this important matter in the past, and as the traffic has increased and the heavier sections been introduced they have entirely changed the economic relations of the wear and deterioration of the permanent way.

The injury to the ties and road bed has been so much reduced by the heavy rails that ties properly treated could be introduced and used with economic results in the United States.

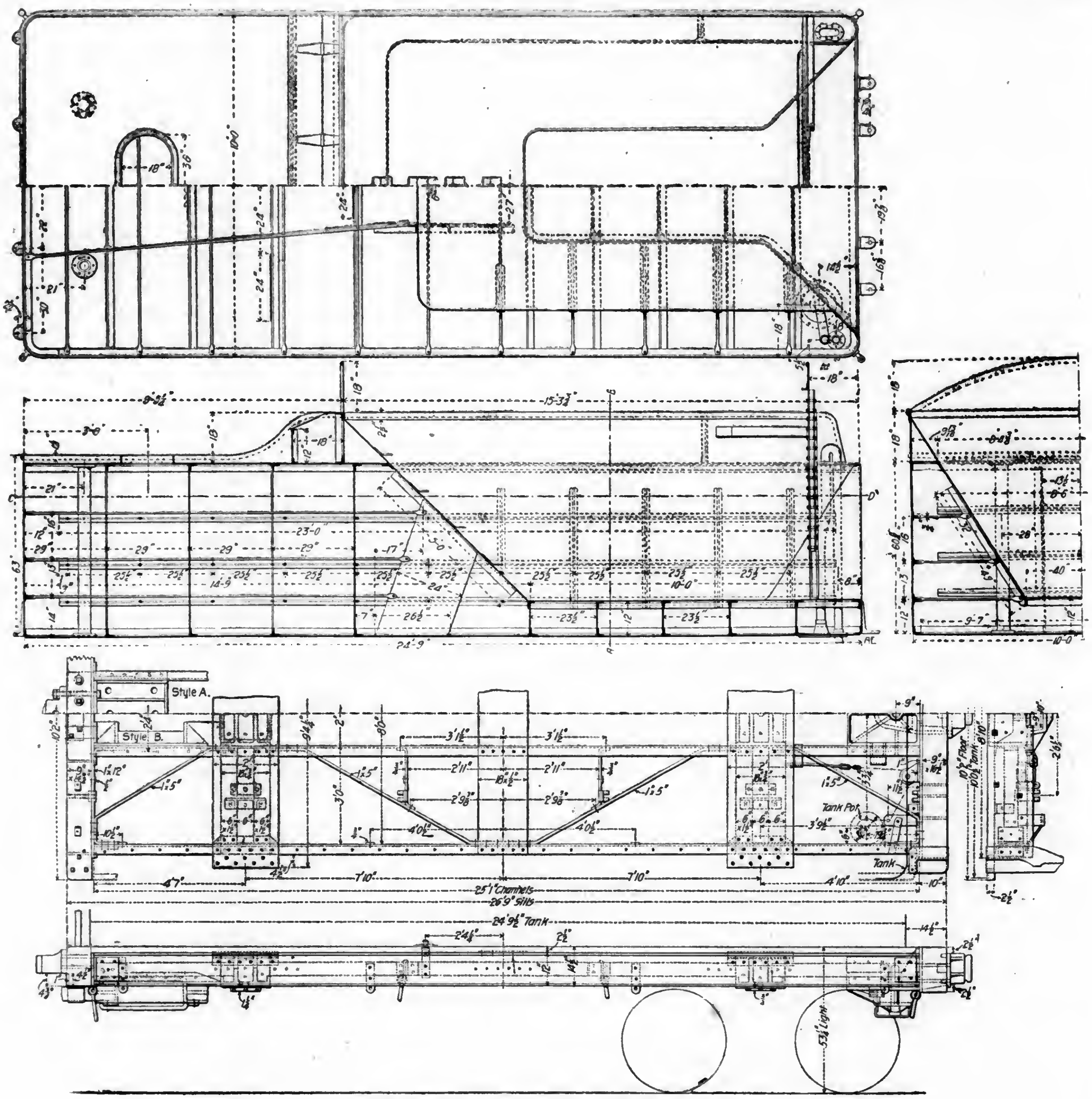
Close attention is paid to the number of miles locomotive and passenger coach axles are permitted to run, but hardly a thought has been given to the limitations of the life of rails due to the repetitions of stresses which take place in the metal of the rails due to the wheel loads of the passing trains. This feature will have as much to do with the limitation of the life of the rails as the question of the wear of the head of the rail.

We cannot expect a return to lighter loads and slower speeds of trains. These are likely to increase. As a measure of safety it is well that the rails do wear rapidly, as that insures removal before they get extremely dangerous as girders.

The principle that the equipment and permanent way form a single means of transport is now established, and that each one should be designed for the other.

In all of this work certain principles must be followed, adapting the construction to the conditions of service. For final economical results the main dependence must be in a broad sense on "hard" tough steel which is the proper "nature of the metal for rails."

A remarkable hydraulic bending machine, capable of bending plates 4 ins. thick without heating, is in use at the Cramp shipyards in Philadelphia.



**Large Tenders—Illinois Central Railroad.
Cistern and Tender Frame.**

LARGE TENDERS.

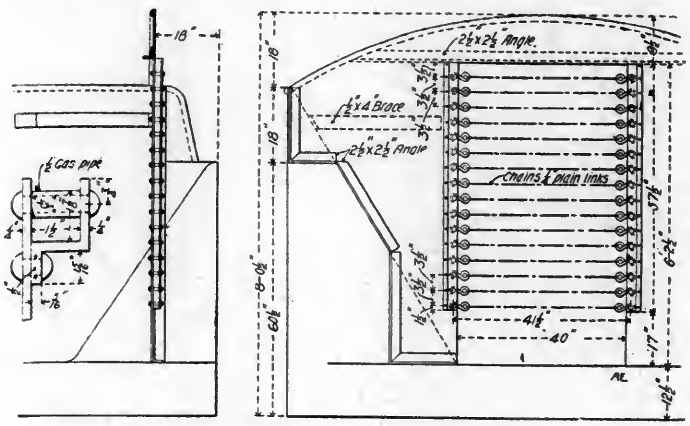
Illinois Central Railroad.

7,000 Gallons Water and 18 Tons Coal.

In the article by Mr. William Forsyth in our June number describing recent practice in locomotive tenders the largest tank capacity shown was for 6,000 gallons. By courtesy of Mr. William Renshaw and Mr. W. H. V. Rosing of the Illinois Central we have received drawings of a 7,000-gallon tender designed by them for use with large engines on that road.

This tank is a combination of the V shape, with sloping sides and ends of the coal space and the water space under the whole of the coal space. The total length of the tank is 24 ft. 9 ins., the height of the rear portion is 5 ft., the total height over end boards 8 ft., and that of the water space under the flat portion of the coal deck is 12 ins. The width of the tank is 10 ft. The engraving presents a clear idea of the bracing of the large flat areas, the cellular structure under the flat deck and the bulkhead bracing of the body of the tank which is supplemented by rods and angles. The coal space has a segmental back board 18 ins. high, behind which is a large tool box. The manhole opening is 18 by 36 ins. In the actual construction a slight change was made in the angles, at the junctions of the slopes and the coal deck, but the engraving showing this was unfortunately delayed.

With large engines it is important to aid the fireman as much as possible by bringing the coal down within easy reach. In this tender the back and sides of the coal space converge to send the coal down to a flat deck 10 ft. long by 40 ins. wide. These sloping surfaces extend from the top edges of the coal sides down to this narrow deck without any perpendicular sur-



End Views, Showing Chain Gate.

faces. About 60 per cent. of the coal is expected to slide down to the flat deck.

The coal gate is novel. The front of the coal space terminates at a plate bulkhead with an opening 40 ins. wide. Across this opening 16 chains of ¼-in. iron and plain links form the coal gate. They are hung on pins at each end by hooks of ½-in. round iron. The chains hang 3¼ ins. between centers and the gate is neat, light, convenient and durable. Over the top of the gate in front is a front end board carried to the same height as the one at the rear. It is obvious that these chains permit of breaking lumps of coal at the front end of the load without opening the gate, which is an important advantage of this form of gate.

The drawing of the frame illustrates its construction sufficiently to make it clear without explanation. These tenders have Fox trucks with floating bolsters and they are equipped with the Westinghouse friction draft gear. They weigh 147,000 lbs. when loaded with 7,000 gals. of water and 16 tons of coal. The light weight is 57,500 lbs.

The Brotherhood of Locomotive Firemen has appropriated $9,000 as a nucleus for the erection of a home for aged, crippled and invalided trainmen. If other organizations of railroad employees connected with train service follow this example it will be possible to carry out the project. While the work done so far is entirely preliminary, the general plan for the establishment of the institution has been well worked out and the present intention is to locate it somewhere in the central West.

"Why has the swing-beam truck so largely been abandoned from freight service?" was the subject discussed at the October meeting of the New York Railroad Club. The three reasons brought forth and emphasized during the discussion were: First, that it costs more to build a swing-beam than a rigid truck. Second, that freight car trucks are not watched as closely, nor given nearly the attention that passenger car trucks receive, so that there is more or less trouble from continual failures due to a large number of parts, thus making the cost of maintenance for the swing-beam truck very large, and, Third, with the improved condition of tracks the present steel trucks meet all the requirements and give good results. As no regular paper was presented at this meeting, a second subject for discussion was called for from Mr. M. N. Forney, who read an article on the "Possible Economies in Locomotives," written by himself for the American Engineer and Railroad Journal. This subject was discussed from the standpoint of economy in the simple and compound locomotives and it was evident from Mr. Forney's remarks that he has great faith that the economy of the simple engine will be considerably increased.

A PLAN OF EDUCATION FOR RAILROAD MEN FOR SUBORDINATE POSITIONS OF RESPONSIBILITY.

After considering this subject for a number of years and studying the conditions here and abroad, Mr. Walter G. Berg, Chief Engineer of the Lehigh Valley, presented his views in a paper read before the Association of Railway Superintendents of Bridges and Buildings last month, at St. Louis. The discussion is too long to be given in detail, but the essentials are summed up as follows:

Two courses are open to boys who desire to enter railroad service. First, to enter the shops or the actual work on the road or in an office, and, second, to devote ten years to a technical education. Mr. Berg proposes a plan half way between the two. His argument is presented in three divisions.

First. A clear division should be maintained between the higher and middle classes of railroad men, and the preliminary educational systems should be kept distinct and separate from each other.

Second. The higher class, offering the material from which, as a rule, the future managers, professional men and heads of departments will be drawn, should be provided for by special railway departments at existing colleges, and by adding general railway subjects to the present curriculum of the technical departments of colleges.

Third. The middle class of railroad employees, comprising young men entering the railroad service in subordinate positions of all kinds, many of whom will some day fill the large number of responsible minor railroad positions of trust, should receive, after leaving the ordinary school course, a special short preliminary course adapted to the particular departmental work they expect to take up on entering a railroad shop or office. This special education will be obtained most advantageously in special railroad trade schools, to be established wherever desirable and possible throughout the country, the curriculum to consist of a one-year "Regular Course" divided into suitable departments. Further, an "Advance Course" covering a second year, for scholars who desire and have the means and qualifications necessary to continue their studies to a more advanced point.

The school would offer a regular course of one year and an advanced course of one year, also a general course. The regular course would be for boys, direct from public schools, and young men who, after a few years' work in a shop, office or railroad department, began to realize that their advancement may depend largely on a better general knowledge of some subject or specialty. The advanced course would be open to those who had completed the regular course and who desired to pursue their studies further; also to those whose previous education and railroad experience would qualify them to omit the regular course. The general course, consisting of lectures on general railroad subjects, would be open to all who desire it in order to spread a better knowledge of the general conditions, laws and public policy governing railroads among the general public. The regular course would be complete from a practical point of view and so framed as to meet the needs of practical railroad employees and would not be beyond the reach of such men. The advanced course would build upon the regular course, the subjects being extended and carried to higher grade to include laboratory, drawing-room and workshop exercises. The general course would consist of evening lectures on the most general laws and conditions governing the control, operation and management of public carriers, their relation with the state and the public, their history and influence in industrial, trade and labor questions.

The author of the paper goes into detail with regard to each course, outlining the studies and their arrangement and presents a complete programme of the work which he suggests. He says little, however, about the organization of the schools and the important question of their support, except that he believes it not difficult to provide for their endowment at import railroad centers.

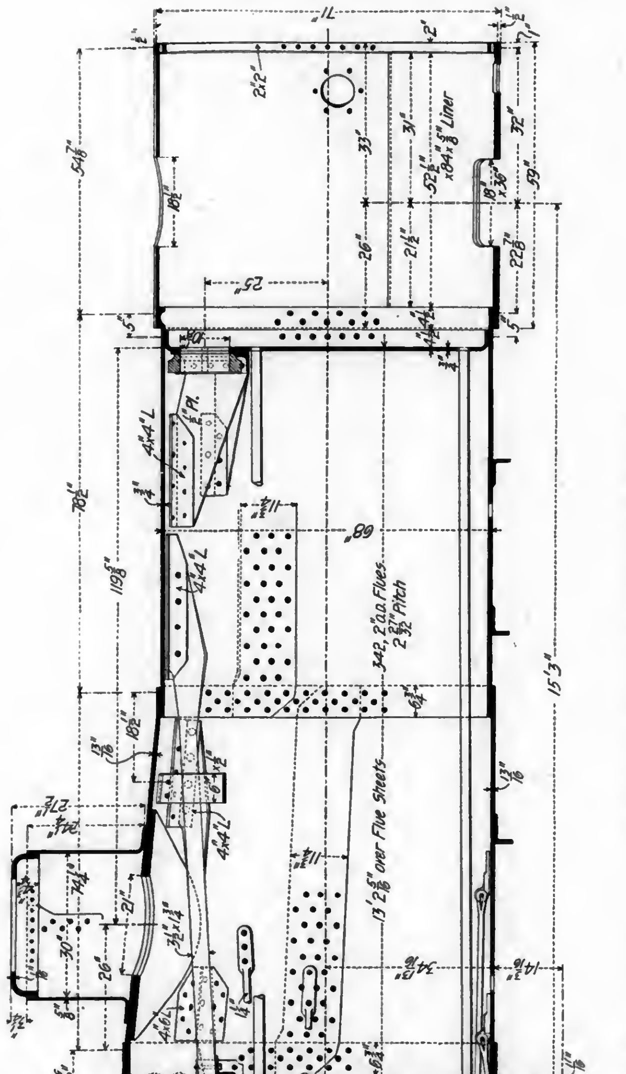
TWELVE-WHEEL WIDE-FIREBOX FREIGHT LOCOMOTIVE.

For Burning Bituminous Slack.

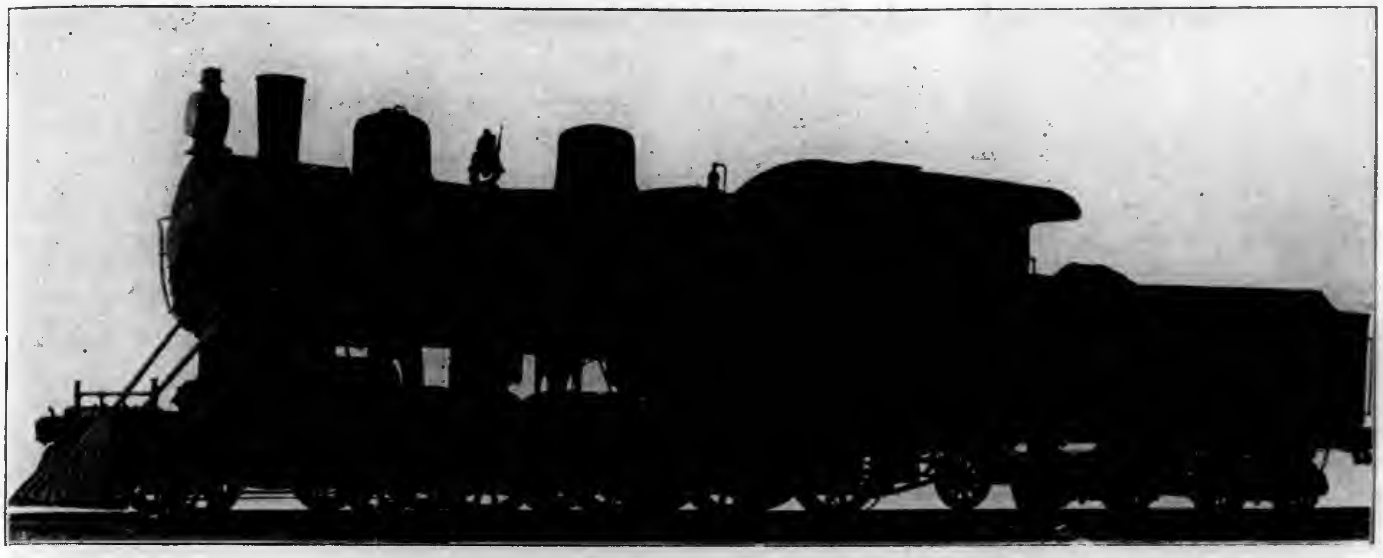
Buffalo, Rochester & Pittsburgh Ry.

This locomotive is interesting chiefly because it was designed to burn bituminous slack in a firebox extending over the rear driving wheels, the construction being such as to bring the engineer and fireman together in the same cab. The boiler is of the Player-Belpaire wagon-top type, with a sloping grate, the depth of the firebox being as great as possible over 55-in. driving wheels. The total weight is about the same as that of the Lake Shore consolidation engines, described in the American Engineer of February, 1900, page 37, but the heating surface is not as large. The B., R. & P. engine has piston valves, extended piston rods, a short front end and brake shoes behind the driving wheels. The grate area is 58.9 sq. ft. This is not large for a wide firebox engine, but it is another step toward what may be expected in general locomotive practice, a careful study of conditions of combustion with a view of building fireboxes to favor the work which they are expected to do. The combination of the Belpaire staying with a grate 6 ft. 8 ins. wide is a novelty which seems to have been worked out very nicely. In the longitudinal section it will be seen that the mud ring is unusually deep. This was done to arrange a good form of ash-pan attachment. This engine is not provided with a brick arch. It has piston valves with internal admission and marine links with short valve travel. The exhaust pipe is a new design by Mr. John Player, Mechanical Engineer of the Brooks Locomotive Works, which seems to be very successful. The following table contains additional information about the design:

Gauge	4 ft. 8½ in.
Kind of fuel to be used	Bituminous slack
Weight on drivers	139,000 lbs.
Weight on truck	33,000 lbs.
Weight, total	172,000 lbs.
Weight tender, loaded	110,000 lbs.
General Dimensions.	
Wheel base, total, of engine	25 ft. 8 in.
Wheel base, driving	15 ft. 6 in.
Wheel base, total, engine and tender	52 ft. 11¼ in.
Length over all, engine	38 ft. 8¼ in.
Length over all, total engine and tender	61 ft. 11½ in.
Height, center of boiler above rails	9 ft. 1 in.
Height of stack above rails	15 ft. 0 in.
Heating surface, fire box	154.5 sq. ft.
Heating surface, tubes	2,361 sq. ft.
Heating surface, total	2,515.5 sq. ft.
Grate area	58.9 sq. ft.
Wheels and Journals.	
Drivers, number	Eight
Drivers, diameter	55 in.
Drivers, material of centers	Cast steel
Truck wheels, diameter	30½ in.
Journals, driving axle	8½ in. by 10 in.
Journals, truck axle	5½ in. by 10 in.
Main crank pin, size	6¼ in. by 6 in.
Main coupling pin, size	7 in. by 4¼ in.
Main pin, diameter wheel fit	7⅜ in.
Cylinders.	
Cylinders, diameter	20 in.
Piston stroke	26 in.
Piston rod, diameter	4 in.
Main rod, length center to center	98½ in.
Steam ports, length	22 in.
Steam ports, width	2 in.
Exhaust ports, least area	75 in.
Bridge, width	2⅝ in.
Valves.	
Valves, kind of	Improved piston
Valves, greatest travel	4 9/16 in.
Valves, steam lap (inside)	⅞ in.
Valves, exhaust lap (outside)	Line and line
Valve Motion, Forward Gear.	
Lead, full gear	—3/32 in.
Lead, 6 in. cut off	+3/16 in.
Port opening, 6 in. cut off	7/32 in.
Pre-admission, 6 in. cut off	9/16 in.
Exhaust opens 6 in. cut off	17 7/16 in.
Cut off, full gear	22 1/16 in.
Valve Motion, Backward Gear.	
Lead, full gear	+3/32 in.
Lead, 8 in. cut off	+13/64 in.
Port opening, 8 in. cut off	21/64 in.
Exhaust opens 8 in. cut off	19 in.
Cut off, full gear	20⅞ in.
Boiler.	
Boiler, type of	Player Belpaire wagon top
Boiler, working steam pressure	210 lbs.
Boiler, material in shell	Steel
Boiler, thickness of material in shell	¾ in., 13/16 in., 11/16 in., ⅝ in., 9/16 in.
Boiler, thickness of tube sheet	¾ in.
Boiler, diameter of shell, front	68 in.
Boiler, diameter of shell at throat	78⅛ in.
Boiler, diameter at back head	68⅛ in.
Seams, kind of horizontal	Sextuple, lap
Seams, kind of circumferential	Triple, lap
Crown sheet stayed with	Direct stays
Dome, diameter	30 in.



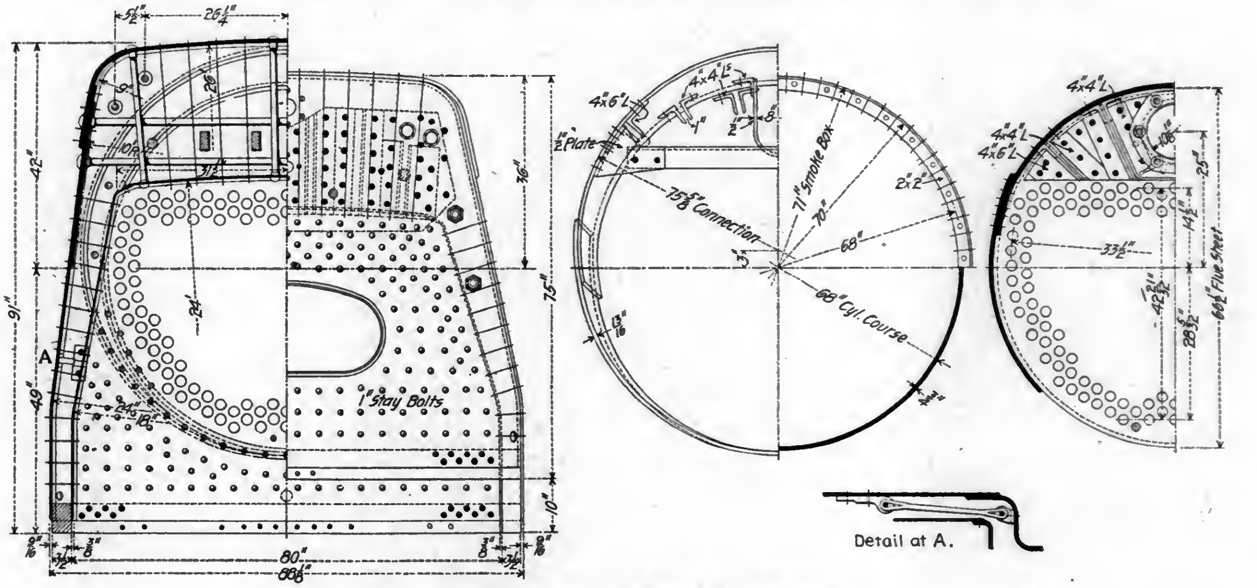
Twelve-Wheel Wide Firebox Freight Locomotive—Buffalo, Rochester & Pittsburgh Railway.



TWELVE-WHEEL WIDE FIREBOX FREIGHT LOCOMOTIVE.

Buffalo, Rochester & Pittsburgh Railway. Brooks Locomotive Works, *Builders.*

Weights: Total of engine ....172,000 lbs.; on drivers..........139,000 lbs ; total of engine and tender .....282,000 lbs.
Wheel base: Driving.... ..15 ft. 6 in.; total of engine........25 ft. 8 in.; total of engine and tender ... . 52 ft 11¼ in.
Cylinders: 20 x 26 in. Wheels: Driving, ...55 in.; truck .. ..30½ in.; tender ......33½ in.
Boiler: Diameter . ...68 in.; boiler pressure........ 210 lbs.
Firebox: Length ....108 in.; width............80 in.; depth, front.... ....64 in.; back. .... 48 in.
Grate area ....58.9 sq. ft. Tubes 342, 2 in ; 13 ft. 2 in. long.
Heating surface: Tubes .... 2,361 sq. ft.; firebox...........154.5 sq. ft.; total.... 2,515 sq. ft.
Tender: Eight-wheel; water capacity, 5,500 gals.; coal capacity...........12 tons.



Sectional Views of Boiler and Firebox.

Fire Box.

Fire box, type	Long sloping over wheels
Fire box, length	108 in
Fire box, width	80 in
Fire box, depth, front	64 in
Fire box, depth, back	48 in
Fire box, material	Steel
Fire box, thickness of sheets	Crown, ⅜ in.; tube, ⅝ in.; sides and back, ⅜ in.
Fire box, brick arch	None
Fire box, mud ring, width	Back, 3½ in.; sides, 3½ in.; front, 4 in
Fire box, water space at top	Back, 4½ in.; sides, 6½ in.; front, 4 in
Grates, kind of	Cast iron rocking, in four sections
Tubes, number of	342
Tubes, material	Charcoal iron
Tubes, outside diameter	2 in. pitch, 2 27/32 in. centers
Tubes, length over tube sheets	13 ft. 2 5/16 in

Smoke Box.

Smoke box, diameter, outside	71 in
Smoke box, length from flue sheet	63 in.

Other Parts.

Exhaust nozzle	Player improved
Exhaust nozzle, area	24.7 sq. in.
Netting, wire or plate	Wire
Netting, size or mesh or perforation	2½ by 2½
Stack, straight or taper	Steel, taper
Stack, least diameter	18 in
Stack, greatest diameter	19¼ in
Stack, height above smoke box	35 in.

Tender.

Type	8-wheel, steel frame
Tank, capacity for water	5,500 gal
Tank, capacity for coal	12 tons
Tank, material	Steel
Tank, thickness of sheets	3/16 in. and ¼ in
Type of under frame	10 in. steel channel
Type of truck	B. L. W. 100,000 lbs
Type of springs	Triplicate elliptic
Diameter of wheels	33½ in
Diameter and length of journals	5 in. by 9 in
Distance between centers of journals	65 in
Diameter of wheel fit on axle	6⅜ in
Diameter of center of axle	5⅜ in
Length of tender over bumper beams	21 ft. 1½ in
Length of tank	19 ft. 6 in.
Width of tank	9 ft. 10 in
Height of tank not including collar	56 in

A manhole punching machine with capacity to punch a manhole 18 by 27 ins. in size in ¾-in. plates is in use at the works of the Newport News Shipbuilding and Dry Dock Company. It is operated by hydraulic pressure of 1,500 lbs. per square inch.

TRACK TANK WATER SCOOP.

For High Speed Locomotives.

Lake Shore & Michigan Southern Railway.

Among the railroads having track tanks several are making careful studies of the design of water scoops with a view of improving practice in several important particulars. Having invested in the track tanks, their use by freight as well as passenger engines is desired, which renders it necessary to take water at a wide range of speeds from about 12 to 60 and 70 miles per hour. With present designs it is difficult, if not impossible, to take water at slow speeds, and the splashing of the water at the mouth of the scoop at high speeds has been found to cut down the delivery to an extent which renders it impossible to take enough water with the present length of troughs. It has also been difficult to raise the scoops when running fast. The problems of easy elevation and of preventing splashing have been studied with special care in the design which is illustrated by the accompanying engravings, prepared from drawings received through the courtesy of Mr. H. F. Ball, Mechanical Engineer of the Lake Shore & Michigan Southern Railway. These present a design worked out by him for use on the fast passenger locomotives of that road and they will also be used in freight equipment. Mr. Ball desired to meet the following conditions:

A construction which would permit of raising the scoop at speeds as high as 70 miles per hour by hand.

One which would not require machine work on the working joints of the connections to the stationary conduit.

One which would not splash the water at the highest speeds, and

One which would permit of a power-lifting attachment in the form of a pneumatic cylinder.

There are two movable sections at the lower end of the conduit, one which embodies the dipper itself and a second one forming a connection between the dipper and the fixed conduit. To secure easy lifting at high speeds the reaction due to the thrust on the movable portions, which is caused by the water, must be made as small as possible, unless the balanced construction of the Pennsylvania design, as shown in our issue of November, 1896, is adopted. This is done in the Lake Shore design by making the lower section, which includes the mouth, as short as possible in order to reduce to a minimum the thrust of the water on the projected area of the resisting surface. Therefore, the first joint is very near the mouth of the scoop, where a slight elevation takes the cutting edge of the scoop out of the water and soon changes the angle to one which will secure the help of the water to finish withdrawing the scoop from the trough. In Fig. 1 the first movement of the lever raises the end section about its joint and when the front edge is out of the water, or soon after, the three-link chain becomes straightened and begins to lift the end of the second as well as the first section. The plate spring assists in the initial movement because it is deflected slightly in order to get the scoop down into the trough to take water. It is obvious that either hand or pneumatic power may be connected to the operating arm. Tests in service have demonstrated the ability of one man to lift it when taking water at speeds of 74 miles an hour, and there is no doubt that it can be handled by one man at 79 miles an hour, the highest speeds reached in the experiments.

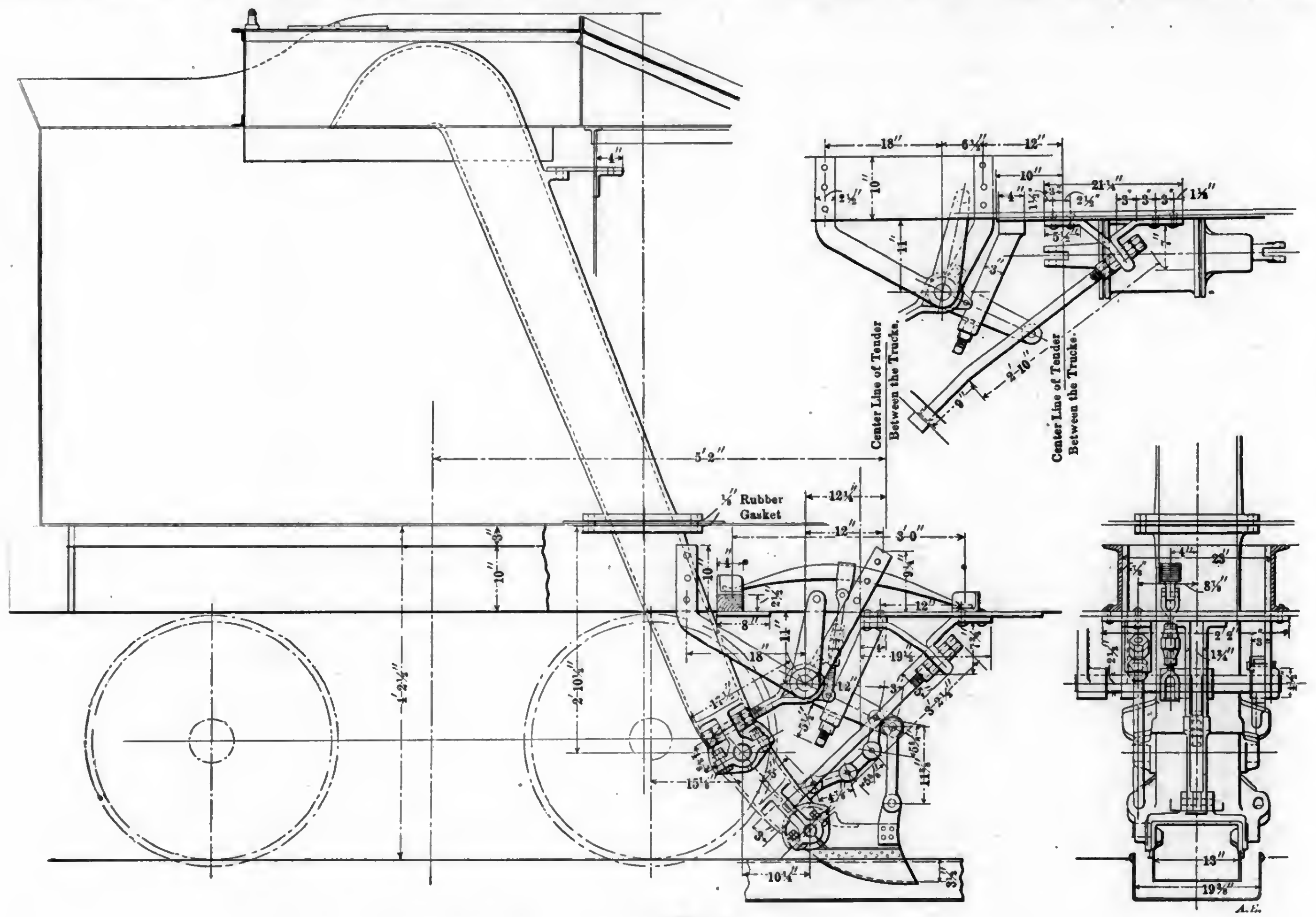


Fig. 1
Track Tank Water Scoop.—Lake Shore & Michigan Southern Railway.

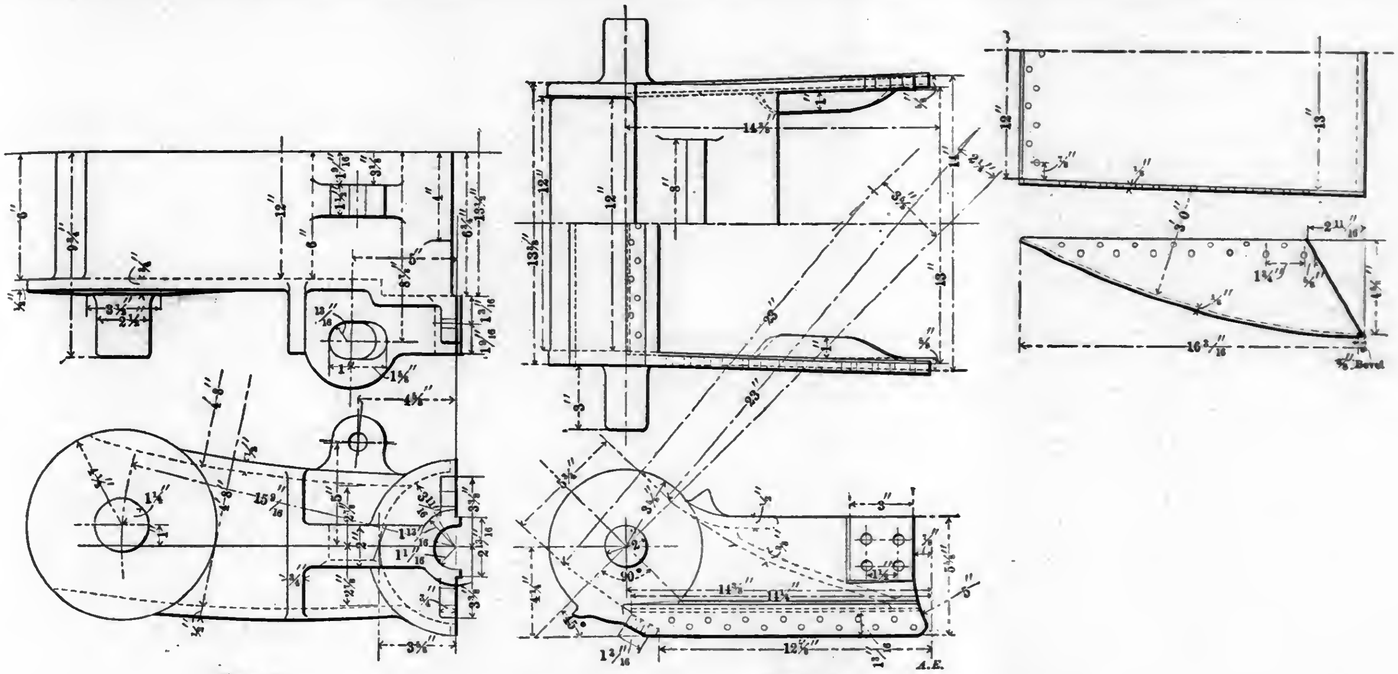


Fig. 3. Fig. 2

Track Tank Water Scoop.—Lake Shore & Michigan Southern Railway.

The stationary conduit is of cast iron, ½ in. thick, jointed at the floor of the tank by a gasket joint. The mouthpiece, which is riveted to the lower movable section, Fig. 3, is of steel plate and the rest of the parts are of malleable iron with no machine finish at the water joints. The movable sections of Figs. 2 and 3 are secured at the joints by trunnions and caps, the form of the parts at the joints being such as to offer no obstruction to the water when the mouthpiece is lowered into the trough. There is no tendency to leak, because the water is handled as in a turbine water wheel, by virtue of its velocity instead of pressure.

The performance of this scoop is remarkable. Even with a dip of 4½ ins. into the water there is no difficulty in raising it, and tests carried out early in October showed it to be very satisfactory as regards splashing. In this it is in marked contrast with the comprehensive waste which usually accompanies the scooping of water at high speeds. The tests showed variation in the splashing. At 50 miles per hour there was none outside of the rail and at 79½ miles a light spray was thrown to a distance of 5 ft. 6 ins. from the outside of the rail. The following record gives the distance of the splashing from the outside of the rails:

Tests of October 9, 1900.

Speed.	Dip of scoop.	Splash.
50	4 in.	None.
39	4 in	Light spray, 18 in.
66	4 in.	Spray, 4 ft. 6 in.
46	3½ in.	Light spray, 4 ft. 6 in., heavier at intervals of about 200 ft.
70	3½ in.	Light spray, 3 ft. 6 in.
Tests of October 10.		
38	3½ in.	None.
19	3½ in.	None.
74	3½ in.	Light spray, 18 in
27	4½ in.	Spray 4 ft. 6 in., heavier at times.
43	4½ in.	Same as at 27 miles.
79½	4½ in.	Light spray, 5 ft. 6 in., heavier at times.

The shape of the curve is such that at the mouth it is nearly tangent to a line parallel with the surface of the water, and the smallest possible amount of the surface strikes the water before the mouth is down. The construction has been made strong enough to withstand an estimated thrust of about 7,000 lbs., due to the resistance of the water. This force is roughly estimated to be necessary to exert in the form of increased drawbar pull due to taking water at 68 miles per hour. The tanks on the Lake Shore are about 1,400 ft. long and it is thought that a length of 2,400 ft. will be ample for filling tender tanks containing 6,000 gals. of water. The scoop previously in use could not be lifted at all when the speed was above 30 miles per hour, which is a good comparison with these tests to illustrate the value of the improved construction. The fact that at 50 miles per hour the ties were not wet at the rails is remarkable and exceedingly creditable to the designer.

In reviewing the tendencies in stationary steam engine practice as illustrated at the Paris Exposition, "Power" finds the most notable things to be the absence of the "mill engine" with its rope or belt drive, all but the smaller engines being fitted with direct-connected generators. It is hardly probable that this can be accounted for on account of economy and convenience alone, but it is thought to indicate a tendency among Continental engineers toward the substitution of electrical transmission for all other methods.

"Bumpers" in the form of mounds of earth seem to be considered the most satisfactory device for stopping cars at terminals of tracks. At the recent convention of the Association of Railway Superintendents of Bridges and Buildings the various forms of bumpers were discussed and it was evident that the development of the ideal bumper was a matter for the future. The necessary resistance for absorbing heavy shocks without involving the breakage of springs was yet to be provided, and where they were permissible simple mounds of earth were considered better than anything yet found.

Oil fuel for locomotives on the Atchison, Topeka & Santa Fe in Southern California appears to be giving most satisfactory results, as the annual report of this road comments upon it favorably. The road has acquired oil lands at Fullerton and is pumping several wells there. A branch line 4¼ miles long has been built to reach these fields. Others have been opened up near Bakersfield and Fresno. All the engines of the San Francisco & San Joaquin Valley are being fitted up to burn oil and also the engines of the Santa Fe & Pacific running between Mojave and the Needles. It is expected that nothing but oil will be burned on locomotives of the lines of this company in California at the end of the present year.

LARGE LOCOMOTIVE FIREBOXES.

Their Influence on Combustion.

By A. Bement.

The most favorable size of locomotive fireboxes or, in other words, the proper amount of grate area, is a question which has forced itself before the motive power departments, especially of those roads using bituminous coal; and without doubt is the most important problem now before these officials.

When the fact is noted that in general practice grate surface has remained at about the same area for several years, while all other features of locomotives have increased enormously, the question is raised whether former grates were too large or present ones are too small. As illustrating this matter I compare an engine of ten years ago, which is designated as No. 1, and another of more recent date, as No. 2:

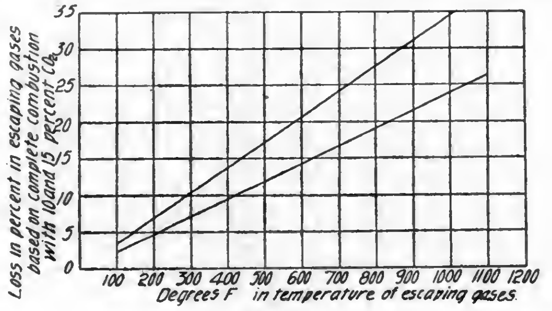


Fig. 1.

	No. 1.	No. 2.
Cylinders	18.5 x 26	23 x 32
Grate surface, square feet	33	33.5
Heating surface, square feet	1,900	3,222
Weight on drivers, in pounds	91,000	208,000

Here is a case of one engine twice as large as the other with almost no difference in grate area. It may be assumed that the draft-producing action of the exhaust is the same in both cases. This being true, it necessarily follows that the grate of No. 1 is too large or that of No. 2 too small. The best, most direct and least expensive way to determine this is by proper analysis of the gases and study of the combustion process, but there is other evidence at hand serving the purpose. If No. 1 grate is too large the air supply will be excessive, and the economic performance of the boiler will suffer owing to loss of energy employed in heating air not used, and passing away at the temperature of the escaping gases. This condition is illustrated by Fig. 1, where the upper curve shows the loss with an average good condition of combustion at different escaping temperatures, and the lower one with a very good combustion. It is, of course, understood that these curves are based on the supposition of all of the carbon being oxidized to CO_2 and none to CO, because their purpose is to illustrate the tendency of the performance of engine No. 1 provided its grate is too large. Now, if it is assumed that No. 1 grate is too large and No. 2 the right size, then engine No. 2 would show more economic performance, and more boiler horse-power owing to more coal being burned, resulting in the production of combustion gases better suited to the use of the boiler. But as the matter actually appears the tendency is for the efficiency to drop off as the size of the engine increases in proportion to the grate surface, therefore, it is evident that engines illustrated by No. 2 suffer from too small grates and from small air supply.

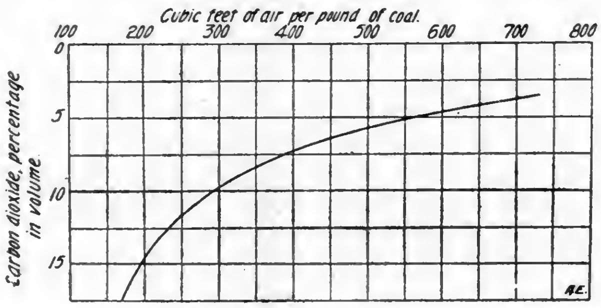


Fig. 2.

It would have been better had the combustion process been studied at the start, when this tendency could have been determined, rather than to have gone ahead developing a large steam-using portion of the machine without a corresponding steam-producing capacity. As it is, experience has shown what could have been determined by experiment.

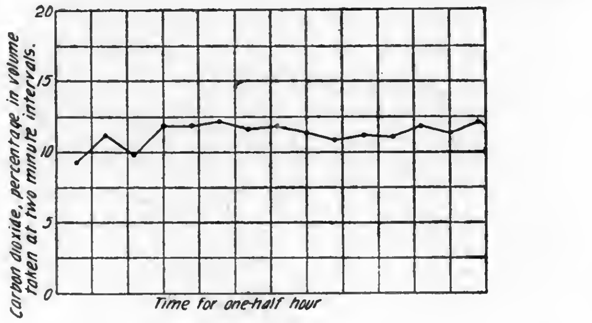


Fig. 3.

I would emphasize the fact that the performance in the firebox is essentially a chemical process, and should be examined by chemical methods and means, because if the matter is so handled, and in an intelligent manner, results of great importance may always be obtained. Viewing the matter from the standpoint of the firebox it must be said that it is an apparatus for the manufacture of CO_2, H_2O and SO_2, and it is important that it shall produce as large quantities of these products as possible, using the minimum amount of material. Here the work of the firebox ceases and that of the boiler begins. If the combustion is incomplete by reason of insufficient air supply the efficiency of the combination of firebox and boiler will be low owing to undeveloped heat for which the furnace, and not the boiler, is responsible. If air is present in the gases the efficiency will be low, owing to lower temperature and greater volume of gases to be cooled. This is also the fault of the furnace. The effect of increased volume is illustrated by Fig. 2.

The tendency for the gases to pass away from the boiler at a lower temperature with incomplete combustion is well illustrated by the following data:

	A.	B.
Temperature of escaping gases	643	633
Coal, pounds per hour	3,221	2,269
Steam, pounds per pound of coal	5.45	6.80

These performances were from the same boiler, same furnace and coal.

As it appears that engines with relatively small grate areas suffer from incomplete combustion, it is evident that larger air supply is required; this may be nad from more grate surface, and in this line the Chicago, Burlington & Quincy and Chicago & Northwestern railways have adopted means which should be successful. I refer to the locomotives illustrated in the American Engineer, April, 1900, page 103, and August, page 237.

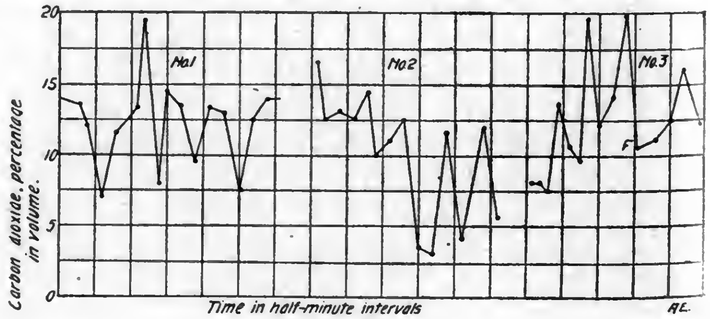


Fig. 4.

In addition to increased air supply, larger grate area will

allow of a greater accumulation of refuse before the fire will become seriously dirty. These are features which have to do strictly with the size of grate, but there is another which I consider important, and that is the location, which must be different from that of the small grates. When fireboxes were placed between the frames the fireman dropped coal down into a chamber; when they were placed above the frames he was afforded an opportunity for better stoking, and with the "Prairie" and "Northwestern" types there is still better opportunity for good stoking. This is a matter which I consider of the very greatest importance, and while it is, of course, acknowledged, I would say that from my experience it is much more important than is generally realized. As illustrating this point the following experiment will be of interest as showing what may be accomplished by good work.

Heating surface, square feet	3,332
Furnace, hand-fired, shaking grate	
Grate surface, square feet	44.6
Coal, Illinois screenings	
Coal burned per hour, pounds	3,221
Coal burned per square foot of grate per hour, pounds	72.2
Temperature of escaping gases, F.	936
Co_2	11.2
O	7.8
CO	0.2
Draft in inches of water at fire	0.35

This was a short experiment undertaken to illustrate the possibilities when the firemen are intelligently instructed. It will be observed that while the draft is very low, there was enough air present for considerable more coal, as shown by 7.8 per cent. oxygen. Fig. 3 shows the curve of carbon dioxide for one-half hour plotted from observations taken at two-minute intervals from an econometer. It shows a fairly uniform combustion, but if an effort had been made this curve might have been approximately a straight line, and would have reduced the very small amount of CO. This experiment is presented to indicate in a measure what should be expected from the larger locomotive grates mentioned, and this line of development should lead to a better combustion, and it may also afford oppportunity for lower pressure of blast and a freer exhaust.

Some curves from a small firebox locomotive showing the rapidly changing conditions of combustion are presented in Fig. 4. These are selected sections of curves covering longer periods of time. As will be noted, the greater number of the analyses were at one-minute intervals, but some were taken at three-quarter and half-minute periods. Nos. 1 and 2 were taken on the road, while No. 3 was from an engine on the testing plant. These curves show a most remarkable change in conditions, and it is interesting to note that the theoretical of 19 per cent. CO_2 is recorded three times; this condition, however, existed but for an interval probably not exceeding one second in time. Most of the drops in the curves were caused by incomplete combustion, although some were from excess of air. It is almost impossible with such rapid changes to determine the cause from the curves themselves, the latter part of No. 3, however, allows of analysis. At the time marked F the fire was coaled, which was followed by a raise to 19.5, which is slightly above the theoretical. This could only have been caused by less oxygen than the average combining with hydrogen, leaving more for carbon, and owing to more than an average amount of coal being present from which the hydrogen had been expelled. After the coaling at F the drop is to 10.5 three-quarters of a minute later. No more fuel having been supplied to the end of the curve it raises in three minutes to 16 per cent., after which it drops in one and a quarter minutes to 12, owing to excess of air.

The larger grate areas should offer the possibility of a performance midway between the two extremes illustrated by Figs. 3 and 4.

There are 28,042 freight cars belonging to the Santa Fe System, 28,024 of which are equipped with air brakes and 27,710 with automatic couplers. The Santa Fe was one of the first roads in the United States to comply with the requirements of the Interstate Commerce Law relating to automatic couplers.

REMARKABLE LOCOMOTIVE MILEAGE.

165,013 Miles Before General Repairs.

We are in receipt of the following letter, under date of October 9th, from Mr. W. C. Arp, Superintendent of Motive Power of the Vandalia Line:

"I thought it would be interesting to you to state the performance of engine 177. This engine was delivered to us in March; went into service on the 23d of the same month and was in continuous service until the month of August this year, making a total mileage of 165,013 miles without being taken into the shop for classified repairs. Had it not been that the engine was in an accident we feel safe in saying that it would have made 200,000 miles. During this time the engine lost 29 trips."

The engine, No. 177, referred to in Mr. Arp's letter is one of four 20 x 26-in. eight-wheel passenger locomotives built by the Schenectady Locomotive Works for the Vandalia Line, March, 1899. The following are the general dimensions of the engine:

Cylinders	20 by 26 in.
Driving wheels, diameter	78 in.
Boiler steam pressure	190 lbs.
Heating surface, tubes	2,066 sq. ft.
Heating surface, firebox	175 sq. ft.
Heating surface, total	2,241 sq. ft.
Grate surface	300 sq. ft.
Weight on drivers	85,800 lbs.
Weight, total	132,300 lbs.

The order placed with the Schenectady Locomotive Works by the New York Central & Hudson River for 20 new passenger locomotives calls for delivery between January and April of next year. The weight of these engines will be about 167,000 lbs., 95,000 lbs. of which will be on the driving wheels. They will have 21 in. by 26 in. cylinders; 79-in. driving wheels; straight boilers with charcoal-iron tubes and a working steam pressure of 200 lbs.; firebox 102 ins. long and 75 ins. wide; and a tender with a capacity of 5,000 gals. of water and 10 tons of coal. The special equipment will include Westinghouse brakes, Sansom bell ringers, National hollow brake-beams and Leach sanding devices.

It is encouraging to note what a prominent factor the night schools are growing to be in the lives of thousands of young men who have, for various reasons, been deprived of the privileges of a complete day-school education. Noteworthy among these institutions offering such opportunities is the West Side Young Men's Christian Association of New York City, 318 West 57th street. Here the very best instruction (both elementary and advanced) is given in science, arts, modern languages, technical instruction, mathematics, music and commercial branches. Very carefully planned courses are offered in simple and advanced mechanical drawing, architectural work, also freehand and water-color instruction.

The performance of a compressed air locomotive and power plant for coal mining service at the mines of the Susquehanna Coal Company, was recently described by Mr. J. H. Bowden before the American Institute of Mining Engineers. There are two lines of railway, one of 4,000 ft. and the other 2,100 ft., with grades varying between ½ and 2¾ per cent., the grades being in favor of the loaded cars. The locomotives were built by the H. K. Porter Company, with 7 by 14-in. cylinders, 24-in. drivers, weighing 8 tons. The air storage has a capacity of 130 cu. ft. under a pressure of 550 lbs. The locomotives work 10 hours a day, one hauling an average of 355 and the other 320 cars per day, weighing, loaded, about 5 tons each. The equipment replaced 32 mules and the entire cost of the plant is saved every 361 working days.

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Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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In some of the brass foundries in railroad shops a large amount of brass is melted, both for bearings and other castings. The usual form of "hole in the floor" furnace is primitive and crude as compared with recent improvements. It is also expensive in the rapid wear and disintegration of the crucibles when they must be handled as much as the usual small ones are in being taken from the furnace for pouring. It is necessary that they should be small on account of the limit of weight which one or two men can carry about. The small crucibles are also wasteful in the consumption of fuel. With a crucible holding 50 pounds of brass, about 1.8 pounds will be melted per pound of coke, and the crucible will give out after 16 or 17 heats. With a modern tilting furnace, recently erected in this country, a 200-pound crucible holding about 570 pounds of metal is handled easily by one man with the aid of simple mechanism for hoisting and tipping. This new furnace gives six heats in ten hours with a loss of about 1.8 per cent., and a consumption of one pound of coke for 3.23 pounds of metal melted. The large crucibles do not suffer at all in handling, and will last for about 26 heats. This is a great improvement over the small hand crucibles, and while such a large furnace is too big for most railroad shops, the idea seems to be a good one for adaptation to such work. The saving in the cost of crucibles alone will pay for the investment. A successful design for large tilting brass furnaces, as used in a German establishment, is illustrated on another page of this issue.

EMANCIPATION OF THE GRATES.

The widening of the grates beyond the limit of 42 ins., which has been the rule for bituminous coal-burning locomotives for many years, is believed to be the most far-reaching and most important improvement in locomotive practice since the adoption of the Stephenson link. It introduces the study of the firebox and grates with special reference to the work they must do, and it means that locomotives are to be built with reference to the fuel they use. Its effect will be seen in economies in the amount of fuel and in its cost, for qualities can now be successfully used which could not be burned on small grates because of the accumulation in the firebox. Other unquestioned advantages are the relief of the fireman and the improvement in the operation of the engine. In addition to these the wide firebox has placed the time for reaching the limits of the power capacity of the soft coal-burning locomotive far into the future, and this without involving a single new principle. In a rather wide personal consultation with motive-power officers, not one objection has been raised or a doubt expressed as to the desirability or advisability of this movement. There seems to be no reason for hesitation in adopting wide grates generally for soft coal engines, and there is every reason to believe that within a short time the number of new engines built with narrow grates will be conspicuously small, because it does not require a refined test to discover the immediate advantages of the wide grate.

Appreciation of the necessity for adapting fireboxes to the fuel was shown by Wootten when he adopted the only possible means for burning the fine sizes of anthracite. In the same way the facts that good soft coal is not always to be had and that the physical endurance of the fireman has been reached have forced the improvement. The determination of the size of grates can not become an exact science until coal becomes uniform in quality. It will require experiment and a certain amount of flexibility must be provided by means of dead plates on roads where an unlimited amount of one quality of coal is not to be depended upon. There need be no danger of getting too much grate area, because dead plates always provide means for making it smaller.

It is not only a question of amount of grate area, but of disposition. The heaviest locomotive ever built would probably be improved by making the length of grate 96 ins. instead of 132 ins., and the width 55 ins. instead of 41 ins., and it is safe to say that a decision to confine the length of locomotive grates to 8 ft. would be a wise one. Another recent design of very heavy engine of the 12-wheel type has a grate area of 37.5 sq. ft. This is large for the narrow type, but no one will question the superiority of the same area obtained with a reduction of length from 11 ft. to 8 ft. D. L. Barnes was right when he said: "No man can fire an eleven-foot grate and make a job of it unless he is a very big man."

The wide firebox brings us to an interesting stage in locomotive development, because of the intimate relation between the grates, the wheel arrangement, the height of the boiler and the length of tubes. It brings up old questions, such as the effect of decreasing the depth and increasing the length

of the "flame way," and this, if we are not misled, is to be a question of importance. In designing wide firebox engines it is considered desirable that the engine men should be kept together; at least, judging by six of the most recent designs, this is a prominent object in the minds of the designers. This should be done if other and more important advantages are not sacrificed. A well-known correspondent says: "I am satisfied that a short and wide grate will give better service than the compromises that have lately been gotten up for the purpose of providing a 'social hall' for the engineer and fireman."

There are no constructive difficulties in connection with this improvement. There is no reason to expect an increase in staybolt failures in view of the general opinion that the adoption of improved forms of extremely wide fireboxes for anthracite coal has somewhat allayed the anxiety about staybolt breakages in these boilers. The wide firebox also seems to have opened the way for material improvement in "smokeless firing." It is reasonable to expect this, and it has been remarked by several who have had opportunities to watch the operation of the new "Northwestern" type engine. The blast is lighter and it does not tear the fire, which gives promise of a reduction in spark losses. We cannot at this time think of a single point of view from which the wide firebox appears otherwise than attractive. The reasons for the delay in its adoption are probably that its need has never been felt as it is now. The opinion of such an able experimenter as D. K. Clark was unfavorable to large grates, and he has been often quoted in a way which seems unwarranted under the circumstances. The delay may be due also to this opinion.

D. K. Clark concluded from exhaustive experiments made in 1852 that, assuming throughout a constant efficiency of the fuel or proportion of water evaporated to the fuel, the evaporative performance of a locomotive boiler or the quantity of water which it was capable of evaporating per hour decreases directly as the grate area is increased: "That is to say, the larger the grate, the smaller is the evaporation of water, at the same rate of efficiency of fuel, even with the same heating surface." Clark also said: "There may be too much grate area for economical evaporation, but there cannot be too little so long as the required rate of combustion per square foot does not exceed the limits imposed by physical conditions."

But Clark used coke as fuel and he did not have heavy spark-losses or the present high rates of combustion; probably these may be considered "physical conditions." It can now be said that there may be either too much or too little grate area and that the character of the fuel should govern the decision, and that Mr. Forney's rule (American Engineer, 1898, page 323) is correct, viz.: A grate should always be large enough to consume enough of the poorest fuel that is used to supply the engine with steam at critical times and places, or where it is working hardest, which is usually on grades or perhaps at points on the road where curves and grades occur simultaneously.

It is not sufficient for an engine to be capable of making schedule time under nomal conditions and in good weather. An engine may do this and still be unsatisfactory. A reasonable amount of lost time must be made up and time must be made in bad weather. Extra cars must often be handled and occasionally trains having as many as 15 cars. Railroad officers are rather rudely awakening to the fact that the latest Pullman cars weigh 62 tons and that a weight of 125,000 has been reached in cars for passenger service. The locomotive therefore needs to do more than keep pace with the ordinary increase in the demands brought about by steadily increasing traffic. If these weights are permitted to still further increase, everything tending to augment the capacity of the locomotive will soon be needed. The advent of the wide firebox is opportune and what may be expected of it is indicated elsewhere in this issue in connection with the remarkable performance of one of the new "Northwestern" engines.

SIMPLER AND LIGHTER PASSENGER TRUCKS.

There may be some subtle reason why a truck with six wheels runs more smoothly than one with four wheels and yet it does not follow that a four-wheel truck cannot be made to carry a heavy sleeping car as smoothly as the present complicated truck of the Pullman type, which is practically the standard in use under heavy passenger equipment cars all over the country.

This truck is exceedingly heavy, a pair of them weighing nearly 40,000 lbs. It is composed of an extraordinarily large number of parts and if it must continue to be used considerable simplification should be effected. The writer has counted the number of parts up to 330, not including about 400 lbs. of bolts, in a single truck, and there may be many that were missed. This will convince anyone that it should be possible to secure the desired results in a simpler and cheaper design. That others think so, too, is apparent in the work of several motive power men upon designs of four-wheel trucks which are intended to take the place of those of six wheels under buffet and mail cars. In describing the new four-wheel truck of the Illinois Central last month the comparison in weight and cost of the two types was stated as follows:

	Six-wheel.	Four-wheel.
Weight of two trucks	36,100 lbs.	29,900 lbs.
Cost of two trucks	$1,825	$1,250

There can be no question as to strength when 5 by 9 in. axles are used, but there may be a difference in the riding qualities in favor of the six-wheel truck unless new methods of spring suspension are employed in the four-wheel designs. The saving promised by the four-wheel truck appears to be sufficient to warrant considerable experimental work in this direction and incidentally it will be worth while to consider steel side frames in the interest of simplicity and lightness. The fact that the ratio between the load carried and the weight of six-wheel passenger trucks is about 2 or 3 to 1, and that the same ratio in large capacity steel cars is 8 to 1, is a forcible argument in favor of an examination of the whole question of passenger truck construction, especially in view of the increasing demands upon locomotives.

The Pullman truck should have credit for the good service it has rendered. It has been so satisfactory in general as to have, until recently, escaped the notice of those who are responsible for improvements in rolling stock. It has been strengthened in the time-honored way by the addition of metal to wood until it is a question whether the wood is still needed. To break away from practice which has changed so little for so many years requires boldness and, perhaps, entirely new methods. The present outlook is, however, hopeful, and if the plans now under way are carried out the developments will be interesting, and probably exceedingly important.

The new electric underground railway in London, running from the Bank of England to Sheperd's Bush, six miles, seems to have been greatly needed. The line was opened July 30 and in three days it was used by 260,000 passengers. The cars, locomotives and also some of the ideas of operation are American.

The desirability of using tie plates on softwood ties and on hardwood ties on bridges upon which the track is curved was expressed at the recent meeting of the Superintendents of Bridges and Buildings. The association was practically unanimous in endorsing this practice.

The battleship "Wisconsin" made an average speed of 17.25 knots on her official trial over a 64-mile course on October 11. The run was made in 3 hours, 56 minutes, 56 seconds, with a smooth sea and good weather. This ship was built by the Union Iron Works, San Francisco. Her length on the load water line is 368 ft., her beam is 72 ft. 2½ ins., her displacement is 11,525 tons and her horse-power 11,000.

PERSONALS.

Mr. J. H. Fildes has been appointed General Foreman of the Lehigh Valley at South Easton, Pa.

Mr. Moses Williams has been elected President of the Fitchburg, vice Mr. E. D. Codman, resigned.

Mr. E. D. Sietz has been appointed Purchasing Agent of the Louisville & St. Louis, with headquarters at Louisville, Ky.

Mr. S. D. Kinney has been appointed Assistant Division Master Mechanic of the Chicago & Alton, at Bloomington, Ill.

Mr. John Dalman has been appointed Assistant Master Mechanic of the Pittsburg, Fort Wayne & Chicago shops, at Fort Wayne.

Mr. J. T. Goodwin, Foreman Boilermaker of the Rogers Locomotive Works, has resigned to take charge of the new boiler shops of the Richmond Locomotive Works.

Mr. Bret Harper has been appointed Mechanical and Electrical Engineer of the Detroit, Rochester, Remeo & Lake Orson, at Detroit, Mich.

Mr. W. B. Page has been appointed Master Mechanic of the Pennsylvania, with headquarters at Lambertville, N. J., vice Mr. J. L. Mohum.

Mr. F. N. Dean has been appointed Assistant Superintendent of Motive Power of the Chicago, St. Paul, Minneapolis & Omaha, with headquarters at Sioux City, Ia.

Mr. C. W. Cross has been appointed Master Mechanic of the Michigan division of the Lake Shore & Michigan Southern, with headquarters at Elkhart, Ind., vice Mr. J. O. Braddeen, resigned.

Mr. Willard A. Smith, one of the Directors of the Transportation, Civil Engineering and Army and Navy Departments of the United States Commission to the Paris Exposition, has returned to this country.

Mr. Charles M. Hogan has been promoted from the position of Road Foreman of Engines on the New York Central & Hudson River to that of Master Mechanic of the same road, with headquarters at Buffalo.

Mr. C. C. Robinson, Master Mechanic of the Peoria, Decatur & Evansville, at Mattoon, Ill., has been appointed Master Mechanic of the Illinois Central at Mattoon, the latter road having absorbed the Peoria, Decatur & Evansville.

Mr. F. R. Coates has been appointed Chief Engineer of the Chicago Great Western, vice Mr. H. Ferstrom, resigned, to become Chief Engineer of the St. Joseph & Grand Island. Mr. Coates was formerly roadmaster on the New York, New Haven & Hartford.

Mr. Oscar Antz, formerly in charge of the Car Department of the Lake Shore & Michigan Southern, at Buffalo, and a frequent contributor to the pages of this journal, has been appointed General Foreman of the Locomotive Department of the same road, with headquarters at Elkart.

W. R. Omohundro, Patent Attorney, and member of the firm of Raymond & Omohundro, Chicago, died October 11. He was 39 years old and will be mourned by many. He had a very large acquaintance among railroad mechanical and supply men.

DRAFT GEAR—THE MOST IMPORTANT PRESENT QUESTION IN CAR CONSTRUCTION.

Those who have followed the development of the friction draft gear by Mr. George Westinghouse and have seen its accomplishments will support the belief that it is one of the most important devices introduced into car construction since the advent of the automatic brake.

Ordinary draft attachments have been outstripped by the progress in the direction of heavy cars until the troubles due to the parting of trains, it is safe to say, have become the greatest now met in the operation of trains. The increase of draft gear capacity cannot be obtained by increasing spring capacity alone, because the reaction of springs when applied directly to the cars is as destructive as the weakness of the usual types. The Westinghouse friction draft gear offers the necessary resistance with the property of gradually yielding, both in pulling and in buffing, which is indispensable in the prevention of destructive shocks. Tests carried out a few days ago near Wall on the Pennsylvania Railroad and in Pittsburgh on the Union Railway, upon cars equipped with this gear, produced results which will astonish those who have not given special attention to this device and will surprise those who have done so and who, like ourselves, have appreciated the principles involved in its construction.

The trials at Wall were made with 47 large capacity, wooden, coke cars, which have been in daily use between the Connellsville coke regions and Pittsburg for upward of two years. In this time they have seen hard service and the repairs to the draft rigging have been almost nothing. To this train was attached a heavy Pennsylvania mogul locomotive with 185 lbs. steam pressure and the engineer was amused when told that he was expected to break the train in two. Emergency stops were made at speeds of 20 and 30 miles per hour and with all the air brakes coupled up. Emergency stops were also made with 6, 12, 18 and 24 of the rear air brakes cut out, and yet in no case were objectionable shocks experienced on the rear car. A further test was made by cutting out the brakes on the 23 leading cars and, at a speed of 20 miles per hour, while the engine was rapidly accelerating the speed of the train, the rear angle cock was opened and an emergency application made on the 24 rear cars. The train was brought to a standstill with the throttle wide open, but without any damage to the draft gear. The engineer was then asked to try to break the train in two by taking slack against the ten rear cars upon which the brakes had been set by hand as hard as the brakemen could set them. Although the engineer thoroughly sanded the track in front of and back of the engine and placed the lever in full forward gear he was unable to do any damage or break the train in two by taking all the slack possible and suddenly opening the throttle. This attempt was repeated a number of times. A train of 50 cars was desired for this test, but for some reason only 47 were available.

A still more remarkable test was made a little later on 40 100,000 lbs. capacity steel ore cars belonging to the Pittsburgh, Bessemer & Lake Erie Railroad, which were coupled together on a straight and level track. To this train was attached one of the very large engines built by the Pittsburgh Locomotive Works for the Union Railroad, a part of the Carnegie System, illustrated on page 365 of our issue of November, 1898. This engine, No. 96, weighs 208,000 lbs. on the driving wheels and has 23 by 32-in. cylinders and carries 200 lbs. steam pressure. The tractive power is 53,292 lbs., this being one of the most powerful engines ever built. The hand brakes on the 10 rear cars were set as hard as the brakemen could set them and the engineer of this powerful locomotive was told to endeavor to break the train in two by taking slack against the 10 cars and pulling out as rapidly as possible. The attempt was first made without sand, but as the engine slipped sand was then copiously used, forward and back, and although the engineer tried several

times to break the train in two it was impossible to do this or to cause any damage to the draft gear.

A running test with the brakes on the first half of the train cut out and the rear brakes applied in the "emergency" was then made while the engine was accelerating the speed of the train. This test, however, proved to be less severe than the jerk test already outlined. Emergency stops were also made, but in no instance was any damage done to the draft gear. This locomotive did not slip at all when put on sand, and it evidently exerted its entire tractive force, assisted by the small amount of recoil which the friction draft gear gave.

These tests were carried out in the presence of well-known railroad officials, who remarked that should anything of the kind be attempted with the draft gear in use on their own roads, everybody concerned would be immediately taken out of the service.

It is impossible to fully appreciate the power of this engine for exerting tremendous strains on the couplings without actually having seen it under test. These tests were not made once, but a number of times and on different occasions without at any time breaking so much as a single knuckle. We, therefore, feel justified in the statement made in the first of these paragraphs. The reason no damage was done by the immense stresses imposed was that there was nothing solid to pull against. The friction gear continually yielded to the strain until its capacity was exhausted and when the stresses were removed, it may be said, the resistance yielded as gradually. The principle involved is exactly similar to that in the old illustration of the difference between breaking an object by a blow from a hammer with the object placed upon a yielding resistance and when resting upon an anvil. It is impossible to break a drawbar or anything else of the kind if, by reason of the yielding of the attachment to which it is fastened, the strain upon it cannot be made to exceed its strength.

The question naturally arises among railroad men as to the wear of these friction devices. We are assured that after three years of continuous service the wear of the friction surfaces, those described on page 149 of our issue of May, 1900, cannot be measured by a mirometer caliber.

The break in two tests exhibit but one side of the draft gear question, and while it is an important one the cost of the maintenance of cars should not be overlooked. The repairs associated with draft gear breakage amount to from 20 to 50 per cent. of the total cost of repairs to freight cars. It is not only the draft rigging itself, but also the entire end structures of cars, which are affected. These facts should be considered in connection with the increased cost of adequate draft attachments.

INAUGURATION OF PRESIDENT PRITCHETT.

Massachusetts Institute of Technology.

The formal inauguration of Dr. Henry S. Pritchett, former Chief of the United States Coast and Geodetic Survey, as President of the Massachusetts Institute of Technology took place on October 24th in Boston. Brief addresses were made by Senator Henry Cabot Lodge, by Colonel Thomas L. Livermore on behalf of the Corporation, and by former President Crafts. The principal feature, however, was, of course, the inaugural address of the in-coming president.

Dr. Pritchett's practical experience as director of, perhaps, the most important purely scientific branch of the Government service, rendered his inaugural address upon "The Relation of Educated Men to the State" peculiarly suggestive. He explained that for some years past as an executive officer of the general government, he had been obliged to study the graduates of colleges and of technical schools from the standpoint of their efficiency in comparison with other men rather than from the standpoint of the teacher; from the standpoint of their ability to do things rather than from the standpoint of knowing how to do things. In this capacity he had been forced to consider the relation of educated men to the government, to compare their service to it with the service rendered by others. He called attention to the fact that a constantly-growing proportion of the important places of the government are passing into the hands of college men, and he asked the question whether the training received in our institutions of higher learning merely gave men increased power or did the college life also fit men for patriotic and loyal and unselfish service to the state.

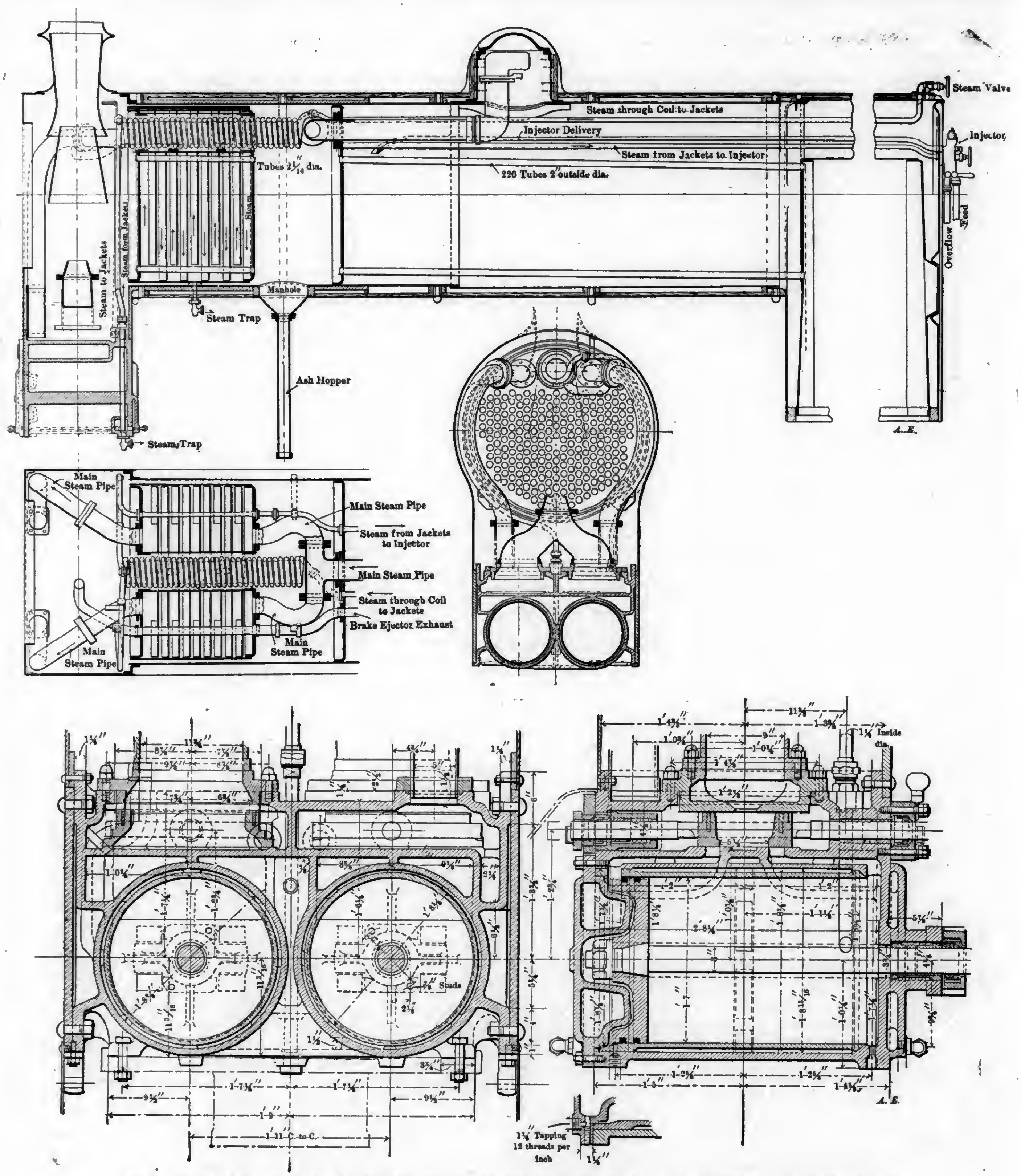
In considering this question he called attention to the fact that the state represents the whole people, that in this capacity it had given generously to higher education both through the general government in land grants and through the state governments by direct taxation. Even our older universities, like Harvard and Yale, had at some time, almost without exception, received aid from the state. Harvard was really founded by the Commonwealth of Massachusetts. The state has, therefore, the right to ask what sort of instruction is being given in our higher institutions, and to know that in these institutions men are trained in high ideals of their civic duties.

While maintaining that on the whole the institutions for higher education had justified the aid which they had received from the state, President Pritchett brought forward certain qualities of education upon which he conceived the state had a right to insist and which had not always been remembered. He said: "The state has a right to expect of those educated in a large measure by its aid a decent respect for the service of the state." He deprecated the widespread tendency to belittle government service, and to ascribe lightly the worst motives to public men. "The Government of the United States," he said, "is honestly conducted, and notwithstanding the crudeness of some legislation and the half-hearted service of a few, those who know best the machinery of the general government have a rational optimism concerning the success of democratic institutions and a wholesome respect for those who work in public service. Educated men will find in increasing numbers their best career in the state's service, and college men should be the last to misunderstand and belittle it."

Another quality of the education given to the youth upon which the state has a right to insist is its catholicity. "No system of education," said he, "is a good one in which students and graduates get out of touch with the great body of their fellow citizens. The higher institutions of learning, if they are to fill their real place, must be not only for the people but of the people."

President Pritchett then took up in the light of these remarks the character of the training which comes from the study of applied science, and called attention to the wise foresight of President Rogers and his associates in estimating the value of a scientific training, not only as a fitting for practical life but also in its development of character. In closing, as he turned to address the great body of students occupying the central portion of the great hall, they rose as one man and remained standing during the five minutes of the president's personal appeal to them. The impressive appearance of this body of young men, 1,250 strong, was one of the features of the occasion.

The aggregate sum of money spent in one year by the railroads of this country is more than many people realize. The Sante Fe informs us through its Advertising Department that that system alone has set aside more than a million dollars for improvements this fall. Two hundred thousand dollars represents the cost to that road of 300 new ballast and coal cars, of the so-called "hopper" style. By their use it is expected that gravel, crushed stone and other ballast can be placed on the track at a considerable saving in time and labor; the cars will also be used to unload coal into pits. Fourteen new dining-cars, two new composite cars, twenty passenger engines and five hundred refrigerator cars are additional important items in the list. The discarded dining-cars will be transformed into wide-vestibuled parlor, buffet and chair cars, thus materially improving those features.



Experiment with Cylinder Jackets and Superheaters in Locomotives.—Lancashire & Yorkshire Railway.

SUPERHEATERS AND STEAM JACKETS FOR LOCOMOTIVES.

Experimental Application in England.

Lancashire & Yorkshire Railway.

This road recently built twenty engines with 19 by 26 in. cylinders, all of which have steam-jacketed cylinders and one of them was fitted with a superheater. It is too soon to expect satisfactory comparison with other engines, but the experiment is likely, in due time, to bring out the value of these attachments.

To insure the proper use of the steam jackets they are made a part of the passage for the steam used in the injectors in such a way that all of the steam going to the injectors must pass through them. This also returns the water of condensation from the jackets to the boiler. The large engraving shows the arrangement of the piping. From the steam valve at the boiler-head the steam enters the jacket pipe which passes inside the boiler to the front of the engine, and in the smoke-

box it is coiled to permit it to take heat from the escaping gases. The return pipe also passes through the smokebox, as shown in the lower left-hand corner of the same engraving, and leads to the injector on the boiler-head. The jackets are formed by cylinder bushings, illustrated in the sectional drawings of the cylinders. It appears that the cylinder-heads, as well as the cylinders themselves, are jacketed.

In the engine having the superheater the boiler was shortened to give room for an unusually long smokebox to contain the superheater. This is a cylindrical shell with tube sheets at each end, having tubes slightly larger than those of the boiler, which was done to permit of drawing the boiler tubes through the superheater tubes for renewals. Sufficient space is left between the superheater shell and that of the smokebox to permit of taking the superheater out bodily when necessary to get at the boiler tubes for extensive repairs. Diaphragms are placed in the superheater in order to make the steam travel throughout its entire volume in its passage to the cylinders and the superheater tubes pass through these diaphragms. The experiment seems already to have shown that the steam is very dry, though the real value in fuel economy is not yet known.

The areas exposed to the steam in the superheater are as follows:

Inside of band plate	40.63	sq. ft.
End plates	29.48	"
Tubes (outside diameter)	360.26	"
Jacket coil (outside diameter)	9.12	"
Total	439 49	"
Internal surface of coil for jackets	29.45	"

In discussing present locomotive practice at the recent meeting of the English Institution of Mechanical Engineers, Mr. J. A. F. Aspinall, General Manager of the Lancashire & Yorkshire Railway, mentioned this experiment as a promising one, and we are courteously permitted to present the drawings. Judging from the fact that twenty engines were fitted with jackets and but one with the superheater, we should say that probably more was expected from the former than from the latter device. We do not, however, know the views of the designer as to this.

THE STEAM TURBINE.

Superheating Improves Efficiency and Power.

Tests on a Le Val steam turbine at Cornell University have shown a remarkable and interesting result of superheating the steam used. Dr. Thurston records in a general way the facts in a recent issue of "Science." He finds that contrary to the usual theory of the steam turbine, a very substantial gain in economy and also in capacity is secured by superheating. This is not because of preventing "initial" or "cylinder condensation," because these phenomena are wanting in the steam turbine, wherein there are no such temperature variations as are known to cause the waste of steam in reciprocating engines. The interior surfaces of the turbine, in steady working, remain at precisely the same temperatures. Nevertheless, the gain in efficiency by superheating was found to be about 1 per cent. for each 3 degs. F. of superheating. Accompanying this was a gain of 100 per cent. in the capacity of the machine by the use of 37 degs. F. of superheat. Dr. Thurston attributes the improvement to the elimination of the friction wastes due to the retardation of the current of fluid traversing the passages of the turbine by concurrent resistances coming of the weighting of the current of steam with drops and mist and the adherence of moisture in mist, drops and even streams to the walls of the steam passages of the turbine. These phenomena will be the subject of further investigation. It is an interesting fact that the gain is substantially proportional to the degree of superheat, which is entirely different from the experience with superheat in reciprocating engines.

CORRESPONDENCE.

FLEXIBLE STAYBOLTS.

Pittsburgh, Pa., October 9, 1900.

To the Editor:

In your comments upon the communication of Mr. C. E. Cardew on Wehrenfennig's and Leach's staybolts, published in your October issue, you say that the experience stated by Mr. Cardew "tends to show how few things are really new." While the correctness of your view, as a general proposition, is undoubted, its expression may seem, to the general reader, to imply that the flexible staybolt of Mr. F. W. Johnstone, of the Mexican Central Railway, to which Mr. Cardew makes reference, is not "really new." Such a conclusion is not warranted by the facts, and I do not think that it was intended by your expression.

By reference of Mr. Johnstone's patent, No. 640,661, dated January 2, 1900, it will be seen that he distinctly disclaims, broadly, "a staybolt which is flexibly connected to a boiler sheet," and that his claims are limited to the form of flexible staybolt invented by him—i.e., one in which a bolt having a spherical head, and threaded at its opposite end, is combined with a plug forming an integral, closed, spherical socket, which is screwed into the outer firebox sheet. The German patent of E. Siegmeth and E. Wehrenfennig, No. 5,571 of 1878 (showing the construction of Fig. 1 of Mr. Cardew's communication), was referred to by the Patent Office in the course of the application for the Johnstone patent, and after consideration by the Examiner, was not held to be sufficient to indicate want of novelty.

The Leach staybolt, shown in Fig. 2, differs from the Johnstone in the substantial and material particular of necessarily employing an independent cap to prevent leakage. The additional expense of providing this cap and securing it in position in the bushing and the increase in the diameter of the bushing which it requires, are objections which I feel confident would prevent it from becoming a competitor of the Johnstone staybolt, even with its advantage of being free from a patent royalty.

I concur with Mr. Cardew in desiring that "honor should be given to whom honor is due," and, as it seems to me, the honor of producing the first entirely practicable and reasonably inexpensive flexible staybolt is due to Mr. F. W. Johnstone. It may not be out of place to add that I am recently informed by him that he is using six rows of his flexible staybolts in each side sheet, and two rows in the top and down the sides of the door sheet, in all new engines, and doing the same when engines are overhauled, and that in the use of these bolts on his road for eighteen months he has never found a broken one.

J. Snowden Bell.

OPERATION OF EQUALIZERS AT HIGH SPEEDS.

To the Editor:

On page 321 of the current number of your paper I notice a letter from Mr. John Hector Graham, entitled "A Suggestion from Swiss Practice," in which the writer refers to himself as "the man who dared to say that the equalizer of locomotives was an antiquated relic which possessed no mechanical or other features to entitle it to a place upon a modern locomotive."

As stated by Mr. F. J. Cole in his excellent article on "The Equalization of Weights," published in the March and April numbers of the American Engineer, "the principal function of an equalizing lever is to equalize the weight between two or more pairs of wheels; also to allow a maximum amount of vertical motion in any one wheel in its relation to the frame of the engine, without too great a deflection of its spring or too great a variation of the load borne by that wheel. If the track is very uneven, and an engine is run over it without equalizers, each spring must in turn deflect enough to com-

pensate for its inequalities, and in doing so the load upon each spring is increased or decreased according to the amount the spring is deflected or released, and the load upon the springs belonging to the other pairs of wheels increased or decreased according to the undulation of the track. If, on the other hand, equalizing levers are introduced, the tension on the springs is uniformly maintained by the levers rocking upon their centers and preserving equal wheel loads."

In precisely what manner Mr. Graham proposes to maintain an equality of wheel loads on uneven track simply by means of a combination of helical and semi-elliptic springs, it is difficult to imagine.

The frequent, although by no means universal, absence of equalizing levers in European locomotive practice does not constitute a valid argument in favor of their abandonment in America, for the adhesive weights of foreign locomotives being much smaller than those prevailing in this country, the destructive effect on rails and bridges of sudden variations in wheel loads is proportionately diminished, and hence the necessity for equalizing levers is less urgent in Europe than it is with us.

While strongly advocating the employment of equalizers between locomotive driving springs, the following question relative to their effectiveness at high speeds suggests itself:

Assume the case of a four-coupled passenger engine having a driving-wheel base of 8 ft., and traveling at the not unusual speed of 70 miles an hour, equivalent to $\frac{5,280 \times 70}{60^2} = 102.67$ ft. per second.

If, now, the forward driving wheels encounter an inequality of rail surface, and their springs are thereby unduly deflected, in order to relieve this excess of load, by transferring it, either wholly or in part, to the adjacent springs before the latter are in their turn deflected by the rear drivers passing over the inequality, the inertia of the equalizing levers, etc., must be overcome, and the transfer of excess load effected in the $\frac{8}{102.67} =$ 0.078 of a second.

The question which presents itself is whether or not the levers can effect an appreciable equalization of spring tension and wheel load in so short an interval of time.

Edward L. Coster,
A. M. Am. Soc. M. E.

New York, October 18, 1900.

C. M. HAYS TO BE NEXT PRESIDENT OF THE SOUTHERN PACIFIC RAILROAD.

Mr. C. M. Hays, General Manager of the Grand Trunk, has formally resigned from the service of that road and his appointment as President of the Southern Pacific to succeed the late Collis P. Huntington will be recommended to the directors of the Southern Pacific this week by a special committee. He was born in Rock Island, Ill., May, 1856; entered railroad service in 1873 on the Atlantic & Pacific. In 1877 he was appointed Secretary and General Manager of the Missouri Pacific. He became General Manager of the Wabash System in 1889, and four years later was elected Vice-President, from which position he resigned, to accept a very flattering offer, as General Manager of the Grand Trunk. Mr. Hays will be Operating Officer of the Southern Pacific and will have his headquarters in San Francisco. There will be little or no change in the present executive staff.

Mr. A. M. Waitt, Superintendent of Motive Power of the New York Central & Hudson River, and wife left Saturday, October 13, for California on a month's vacation, the first vacation Mr. Waitt has had in two years.

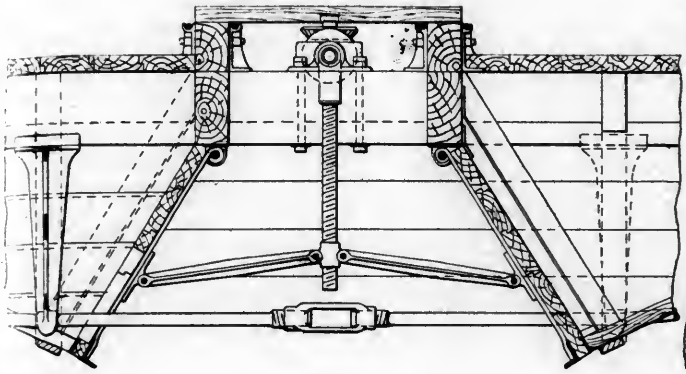
STEEL TUBES FOR LOCOMOTIVES.

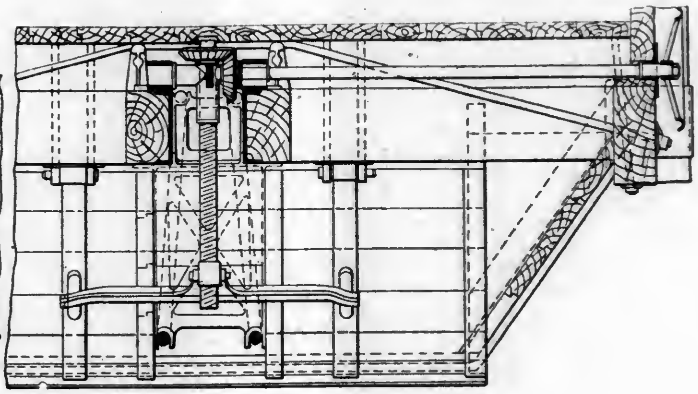
Locomotives subject their tubes to the most severe conditions to be found anywhere in steam-boiler service. Tubes need therefore to be able to meet most exacting requirements, not the least important of which is the ability to stand the repeated applications to boilers necessitated by the frequent renewals in bad-water districts. Steel, because of its homogeneity, has long been considered a desirable material for this purpose, but some of the earliest attempts to use it were not entirely successful because of faults in the material itself. A representative of this journal recently took special pains in visiting a number of prominent motive-power men to ascertain their present views with regard to steel tubes, and particularly those made by the Shelby Steel Tube Company of Cleveland, Ohio. The result was a unanimously favorable opinion, based upon severe tests in the worst water of the middle and far West, and generally with a preconceived opinion that was unfavorable because of earlier failures with tubes of steel. All of those interviewed had their more recent experience with Shelby tubes. The severity of the trials and the excellent results obtained are shown in the case of one of the roads on which a set of these tubes made 78,810 miles on one engine, after which they were applied to another and made 54,694 miles, and finally to a third, with an additional mileage of 39,893, a total of 173,397 miles. This set of tubes is now out of service, but is soon to go into another engine. Another road obtained a service of 107,000 miles with one set without removal and without having the slightest trouble to keep them tight.

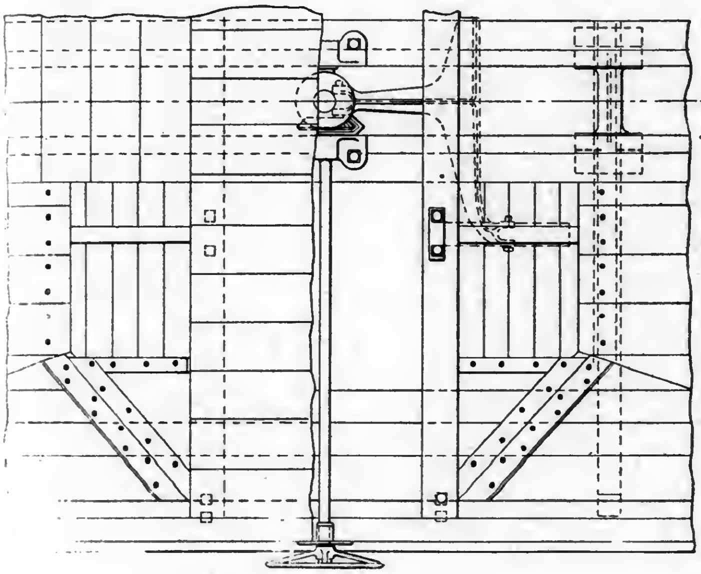
These tubes are uniform in size and thickness. They are straight and homogeneous. They are drawn from solid material, without welds, and the very nature of the process of drawing insures homogeneity. The drawing process would not be applicable to anything but the best material. They are easily cut off and may be rolled quickly and are easily made tight. In one of the cases referred to, a sceptical view of steel tubes led to a number of tests by heating the ends of the tubes and plunging them into cold water, with no apparent injury to the tube, but rather an improvement by the process. This was done by a man who feared that the ends of the tubes would harden under repeated rollings, but this was shown to be a mistake. There is no difficulty in welding them. A master mechanic who has used these tubes for several years in a recent letter expresses the following opinion:

"There seems to be an idea that steel safe ends will not make a good weld with charcoal-iron tubes, but we are welding them right along and have no trouble whatever, as they make nice clean welds. I consider them superior to good charcoal-iron tubes, as they are very pliable and will stand beading and rolling better; in fact, it is impossible to crack them in beading them over. Over two years ago we put a number of cold-drawn tubes in one of our 19 by 26-in. engines and sent her to the south end of our line, where they have the worst water. After 18 months' service I brought the engine to the shop and removed all the flues except the cold-drawn ones, which were in nearly as good condition as when put in, and during this time it was not necessary to use the expander on them. This I consider a good test of the two kinds of tubes, and our experience with them has been perfectly satisfactory."

In marine service also Shelby tubes are very successful. They were fitted to the "Vamoose" two years ago and are reported by the chief engineer as being as good as when first put in. He believes that they will last four or five years longer. This testimony, added to that of the locomotive men, justify the opinion that the steel tube is a success. We have not found any evidence of the slightest difficulty with them, and there seem to be no signs of pitting.







AN INEXPENSIVE HOPPER RIGGING.

Made Without Machine Work.

Central Railroad of New Jersey.

A very simple and effective hopper rigging has been designed by Mr. A. Christianson, of the Central Railroad of New Jersey, for use on double hopper-bottom coal cars of that road. The rigging is inexpensive, reliable, and finds easy application to cars where the distances from the ends of the hoppers to the center of the car are variable.

From the engraving it will be seen that the hopper doors are held up against the hoppers by toggle-arms fastened to the hinges of the doors and to a sleeve-nut which travels a 2-in. screw. This screw is hung midway between the two hoppers, from a shaft passing through suitable bearings on top of the center sills to the side of the car, by an iron casing which is allowed a swinging motion around the shaft. Power is furnished by a hand-wheel at the side of the car to drive a pair of miter-gears in connection with the screw, which is given a rotative motion and in turn imparts a vertical movement to the sleeve-nut, thus raising the toggle-arms and opening the doors to the extreme position shown by dotted lines. In the handling of large lump coal there is a tendency for the coal to bridge itself on the inside of the doors, so as to make the pressure less on one door than the other, and when this occurs the screw in opening will tend to center itself a little to one side and open one door in advance of the other. To guard against this a bracket, not shown in these drawings, has also been designed for use as a guide to the screw and bolted beneath the two center sills.

With the exception of the hinge-pins and shaft, which are wrought iron, the rigging consists of malleable iron castings so constructed as to require no machine work, but put together just as they come from the rattler. The screw is 2 in. in diameter and double threaded. The door hinges can be made of wrought iron and the jaws for the toggle-arms bolted on, or preferably made of malleable iron with these jaws cast on, as shown in the engraving. The door hangers are bolted underneath the cross tie timbers, which make it possible to place the entire hinge on the bottom side of the door and also to use a square edge plank for the first plank on the door. With this arrangement the hinge-bolts can easily be removed and the doors taken down for repairs when necessary.

The hand-wheel is used instead of a crank or wrench and is placed sufficiently close to the side of the car to be protected by the side stakes from the danger of being broken off. There are 24 small lugs cast on the inner circumference of the rim of the wheel into which fits a gravity latch shown in the drawings. The doors by this device have a close adjustment and can be locked in any desired position, placing the opening and closing perfectly under control.

The arrangement of carrying the center sills of the car by two inside truss rods and the stiffening of the side sills by needle beams and tie rods is a suggestion of good car design, but is only one of the different arrangements of under-framing to which the door rigging can be applied. Its experimental application was so satisfactory that it has been specified for a number of new 80,000-lb. coal cars.

Switzerland has not until now been noted as a center for steel production, though her engineers have long held a high position in the mechanical world. Recently, however, a company has been formed to work the great deposits in the Bernese Oberland, where there are many million tons of ore available, averaging 50 per cent. of iron. It is intended to smelt the metal electrically, the large water power, cheaply obtainable, giving the project a reasonable prospect of success.

The Burlington will build 10 wide firebox freight engines of the "Prairie" type and 30 more have been ordered from the Baldwin Locomotive Works. Experience with the wide firebox on this road must have been satisfactory, for the size of this order indicates a great deal of confidence in the principle. These engines will have 20 by 24-in. cylinders, 64-in. drivers and a total weight of 160,000 lbs., with 120,000 lbs. on the drivers. They are for freight service, and will run at comparatively high speeds. No surprise concerning this order will be felt by those who know of the good work of the first examples of this type. We cannot give statistics of their performance, but they are said to be able to "make steam out of anything that goes by the name of coal." There seems to be not the slightest uncertainty in the endorsement of large grates either on the "Burlington" or the "Northwestern."

RAILROAD Y. M. C. A. CONFERENCE.

That a railroad company has more than the two functions—those of transporting freight and passengers—was demonstrated by the very enthusiastic convention of the railroad department of the Young Men's Christian Association, held at the Pennsylvania Y. M. C. A. building, Philadelphia, October 12, 13 and 14, at which 1,000 delegates from all parts of the country and from foreign parts were present. It was evident at this, the tenth international conference, that among the mechanisms of great railroads, men have been made, and that this country has given to the world in its railroad men the finest type of working men.

The opening session of the convention was held on the evening of the 12th, in the large auditorium of the building, and was filled with the enthusiasm of intelligent, earnest workers. A short testimonial meeting, conducted by C. B. Willis, Secretary of the Milwaukee department, preceded the opening session, which was called to order at 7.30 o'clock by Secretary Clarence J. Hicks, of the International Committee. Mr. Hicks presented Mr. C. E. Pugh, Vice-President of the Pennsylvania Railroad, who made the address of welcome. "It has been said," continued Mr. Pugh in his address, "that corporations are selfish, and it has even been intimated in my hearing that the Pennsylvania Railroad is grasping. However that may be, of one thing I am quite sure, it wants the best steel rails, the best bridges, the best equipment and the best men. Right in this building, within this organization, is found the machinery to turn out the men that the railroad wants, and that the railroad needs." He closed his remarks by giving the delegates a hearty welcome from the local association.

The words of welcome were responded to by A. C. Marling, Vice Chairman, in behalf of the visiting friends. Other prominent men spoke briefly. Probably the most interesting event of the day was the reception given by the Ladies' Auxiliary of the Pennsylvania Branch, to the visitors, who were received by Miss Helen Gould and Mrs. Russell Sage, both members of the Ladies' Auxiliary. In the receiving line were also Mrs. A. J. Cassatt, Mrs. Elder, C. E. Pugh, Vice-President of the Pennsylvania Railroad; Secretary C. R. Towson, of the Pennsylvania Y. M. C. A., and other earnest workers in this association. At the conclusion of the reception a substantial repast was served to the delegates.

Many prominent railroad officials of the Pennsylvania system and of other roads were present on the evening of the second day, as it was Railroad Officials' evening. In the morning a business meeting was held and in the afternoon delegates told of the benefit of noonday shop meetings. D. B. Caldwell, General Traffic Manager of the Delaware, Lackawanna & Western, read a paper entitled "The Railroad Employee as a Man." Mr. Caldwell said there was a very general erroneous impression as to the standard of character among the rank and file of railroad men on account of their environment and the nature of their work. The impression was a true one in the pioneer days of railroading when the discipline of the present day did not prevail. But to-day, when railroad construction and operation employ such a large percentage of the population of this country, all must admit that no standard of character is too high. The great interests involved call for men of capability and reliability, and no railway employee can be said to lack for incentive to make the best of himself.

Captain Green, First Vice-President of the Pennsylvania Railroad, paid high tribute to the railroad officials in his address at the evening session. The extension of this railroad work was told by delegates from Germany and Russia, and W. H. Baldwin, Jr., President of the Long Island road, also spoke.

The conference of Christian railroad men was brought to a close Sunday night after two very large meetings—one held in the afternoon and the other in the evening. Both meetings were full of impressive demonstrations.

Monday morning, the 16th, at 9.15 a. m., the delegates left the Broad Street station for Atlantic City, as the guests of the Pennsylvania Railroad.

6,000 STEEL CARS IN A SINGLE ORDER.

Baltimore & Ohio Railroad.

The Pressed Steel Car Company of Pittsburg has set a high-water mark in the matter of large single orders for cars. The one in question being for 6,000 steel cars (4,000 gondolas and 2,000 self-clearing hoppers), of a carrying capacity of 100,000 lbs. each, to be delivered to the Baltimore & Ohio Railroad. Viewed from either standpoint of tonnage, capacity, or money value, the order in question is, beyond doubt, the largest ever given to a single builder before in the history of railroads.

September 28th, at a banquet at the Duquesne Club, Pittsburg, given in honor of a retiring railroad official, and at which were gathered the representative heads of all the largest manufacturing industries, mercantile establishments, and of all the high officials of the roads entering that city, Hon. J. K. Cowan, President of the Baltimore & Ohio Railroad, referred in his speech that evening to the order, as follows:

"For example, I have just concluded a contract with Mr. C. T. Schoen, President of the Pressed Steel Car Company, for 6,000 steel cars, involving the use of steel plate equivalent to that which would be required to build ten of the largest steel freight ships afloat. Four thousand of these cars will be distributed in the Pittsburg district."

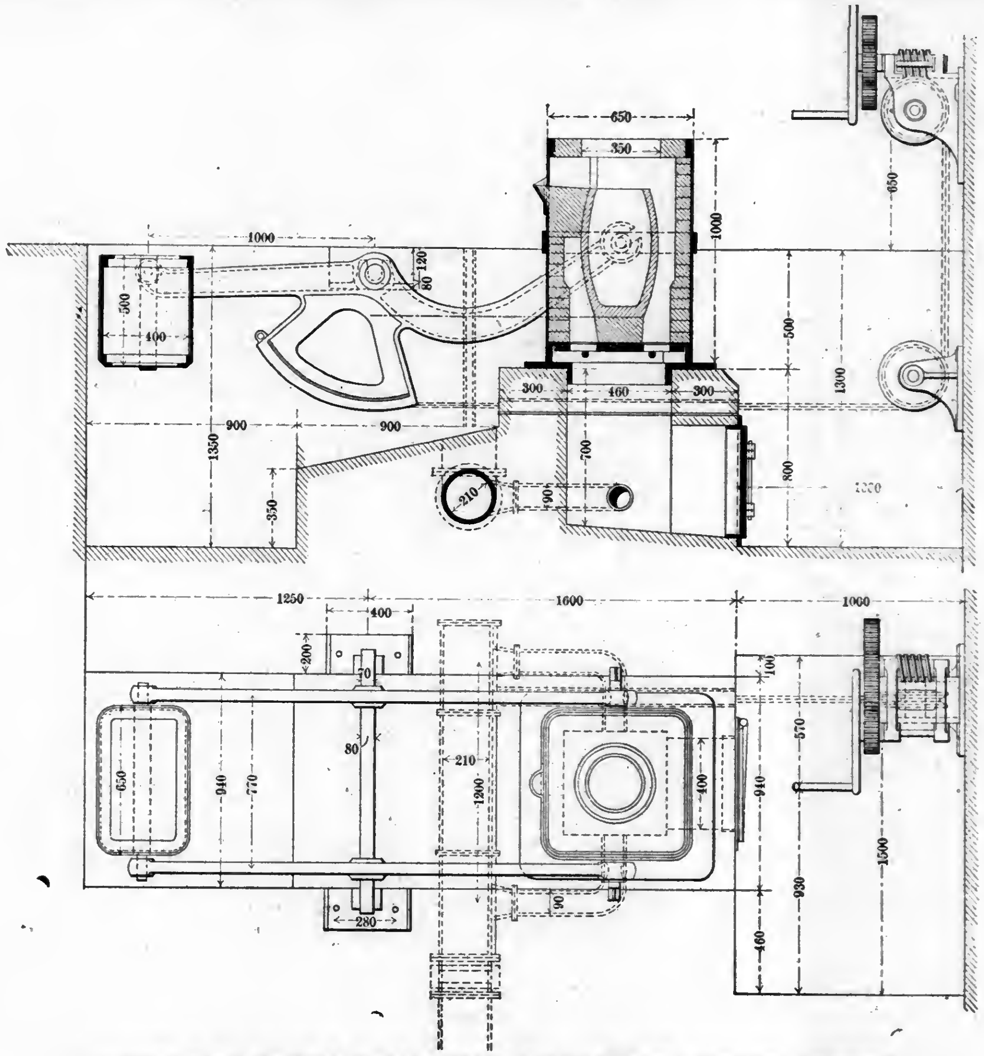
The remarks quoted were made as a part of a speech relating to what the Baltimore & Ohio has done, and is doing, for Pittsburg's interests.

When Mr. C. T. Schoen was pressed for a little interesting data, he at first modestly declined, but upon further solicitation, stated: "The order is undoubtedly the largest ever given, and I would state that the Pressed Steel Car Company, in the last eight days, has taken contracts for steel cars approximating in money value nearly $7,000,000. The amount of steel needed to complete the order will amount to about 100,000 tons. And the most gratifying thing about this all is that it betokens greater things in the future, because, while our business is at present enormous, yet it may be said to be only fairly started into a healthy growth to a normal sturdy stature, as is amply evidenced by the fact that once a road buys steel cars, orders are duplicated, triplicated and quadrupled."

Besides the order mentioned the Pressed Steel Car Company has lately closed with the Union Pacific for 480 steel ballast cars of 110,000 lbs. capacity, and 300 coal cars of 100,000 lbs. capacity; as well as 300 steel cars for the Transvaal, South Africa; and an order of 75 steel cars for the Davenport & Rock Island Railway. These orders combine to make the largest single week's business ever done by any one concern in car erecting circles.

It is estimated that the cost of fuel per year to supply the heat lost through a square foot of unprotected surface of steam piping, such as flanges and valves, under ordinary conditions is about one dollar.

The International Railway Congress will hold its next meeting in Washington, D. C., the invitation of the American Railway Association having been accepted. The next session will be held in October, 1904, and the occasion will offer an opportunity for this country to explain its transportation problems and methods to a large number of most intelligent and progressive foreigners. It will undoubtedly lead to a better understanding of our conditions and we cannot fail to derive many benefits from the presence of so many earnest and enthusiastic railroad men in this country. Our ways of handling business will be searchingly studied and, perhaps, criticised. We should expect this and be prepared to profit by it. One feature of the visit which our supply friends will not neglect is the opportunity to acquaint foreign engineers with the admirable special equipment of all kinds which our system of railroad operation has developed.



Improved Brass Furnace at the Works of Robert Wagner, Schonau, Germany.

IMPROVEMENT IN FURNACES FOR MELTING BRASS.

Small crucibles are generally used in this country for melting brass and their size is limited by the fact that they are handled by two men. A large number are required for heavy work and the wear and tear resulting from the handling is expensive. We are indebted to "The Foundry" for the engraving of a new brass furnace devised by Mr. Robert Wagner of Schonau, near Chemnitz, Germany. In this furnace the metal is melted in a single large crucible and is afterward poured into smaller ones, or ladles, for the moulds. This is a very compact arrangement which saves a large amount of floor space and the labor of withdrawing hot crucibles from the furnace tops is entirely avoided as this furnace is easily tipped for pouring by one man.

The crucible is held securely in a casing lined with firebrick and is elevated to an angle of about 30 degrees with the vertical by means of the chainhoist, quadrant and balance lever shown. In this position it remains stationary. The crucible is then tilted to any desired angle, for pouring into the smaller crucibles, by means of a lever which is attached to one of the trunnions arranged on each side. The crucible illustrated has a capacity of 600 lbs.

The furnace is operated with forced draught, the blast being admitted by the pipe shown in the sectional view. This pipe is 10 ins. in diameter, and supplies two branch pipes which enter the fireplace at opposite sides. In general use the blast has a pressure equal to 6 or 7 ins. of water. No chimney is necessary for the waste gases, these being passed off through a hood and pipe shown in the sectional view. By this method of construction all the heat generated below the furnace must pass over the top of the crucible. When the 600 lbs. of metal have been charged and melted, a gate shuts off the blast pipe. To keep the heat in the furnace a cover is placed on the top as soon as the charging hopper is removed, when the crucible is ready to be moved into the emptying position by the hand wheel and hoisting arrangement previously referred to.

The small crucibles into which the metal is charged hold about 100 lbs. each, and where extra hot metal is desired, they are heated just previous to being used. After all the metal has been emptied from the melting crucible some coke is supplied to the fire, the furnace is returned to its original position, the hopper is replaced and charging begins for the next heat.

Mr. Wagner says that he takes from six to ten heats a day from this furnace, thus melting from 3,600 lbs. to 6,000 lbs. of metal per day. About 200 lbs. of coke are required for each melting. The speed of melting is regulated by the amount of air forced through the furnace. For instance, a charge of 600 lbs. can be melted in from 50 minutes up to two hours, according to the air pressure. With one heat a day the fuel consumption is equal to 36 per cent. of metal melted, while with ten heats in a day of ten hours this is reduced to 20.25 per cent., thus showing quite a gain in fuel through constant operation under a high pressure of blast.

The new express of the Northern Railway of France broke the world's record for long distance performance October 27. The train was composed of the new Compound du Bosquet locomotive and eight corridor carriages running on the Paris-Calais express schedule. According to the New York "Herald," European edition, of October 29, the distance of 185 miles was covered in 184½ minutes, allowing for one stop of 2½ minutes at Amiens, or a fraction over a mile a minute.

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Under the division of heavy trains the Philadelphia & Reading Atlantic City flyer is the fastest, its schedule being 66.6 miles per hour for 55.5 miles. The "Big Four" has a train making 266 miles at 44 miles per hour with 11 stops, and this is done with one engine. Another long engine run of 309.5 miles without change is reported on the Southern Pacific. Other trains are mentioned and the progress in the past 10 years briefly discussed. Mr. Slack sums up the progress in locomotive construction in this time as follows:

1. The later engines are heavier and more powerful;
2. Boiler pressures have increased and design and construction of boilers improved;
3. The compound engine is being used to a greater extent;
4. The area of heating surface in proportion to cylinder volume has been increased;
5. The capacity of tenders, both for coal and water, has increased;
6. The tendency is to use longer piston strokes;
7. The use of piston valves is increasing.
8. Higher piston speeds are used.

A cost of $4.32 for driving all of the rivets, 253 in number, in a standard locomotive firebox of the Baltimore & Ohio Southwestern Railroad is a noteworthy and remarkable result. This work was recently accomplished in nine hours at a cost of 48 cents per hour, with a long-stroke pneumatic riveter made by the Chicago Pneumatic Tool Company. The same work formerly required 15 hours of hand labor, at 73 cents per hour, giving a total cost of $10.95 for hand work. If done by hand snapping, it required 12 hours and cost $7.56, at 63 cents per hour. Pneumatic tools in this case, therefore, saved $6.63 over hand riveting and $3.24 over hand snapping, the figures referring to labor charges only. This is not its only saving, because the greater rapidity of the work results in less delay in the boiler shop, and consequently increases the capacity of the shop. Because of the fact that the boiler shop is often the slowest part of locomotive plants, and also because of large amount of space required for boilers, the question of time in the boiler shop is exceedingly important.

Our attention has been called by Mr. Geo. H. Daniels to the fact that two tickets were recently purchased at the New York Central ticket office in Rochester for Kobe, Japan, a distance of 8,833 miles. The trip requires but three changes, one at Chicago, one at San Francisco and one at Yokohama. The trip will occupy but 27 days. A short time before, the same office sold a ticket for Christ Church, New Zealand, a distance of 13,000 miles.

CHICAGO PNEUMATIC TOOL COMPANY'S EXHIBIT.

Paris Exposition.

This company had three separate exhibits in Paris, one at the main exposition in the Palace of Electricity and Machinery at the Champs de Mars, and another interior exhibit at Vincennes, shown in Fig. 1, and a third in the open air at Vincennes, a view of which is given in Fig. 2.

All three were very elaborate and complete, and where possible the devices were shown in operation, special attention being given throughout to illustrate the machines in connection with their direct application to practical work.

The two interior exhibits in general resembled those at recent conventions of mechanical technical associations in this country, but were made much more complete because of their educational value among Europeans. The open-air exhibit at Vincennes contained much of the same machinery, but it was shown in actual service. The second engraving illustrates a full size section of a steel ship, with the keel, frames, plating and decks, by aid of which the utility of pneumatic tools in ship building was demonstrated in an impressive way. This plant was operated only during certain specified hours and it developed remarkable interest and large attendance.

In this work the fact of the applicability of one pneumatic tool to various operations was made clear, the long stroke riveter being employed in plate, deck and frame riveting, in

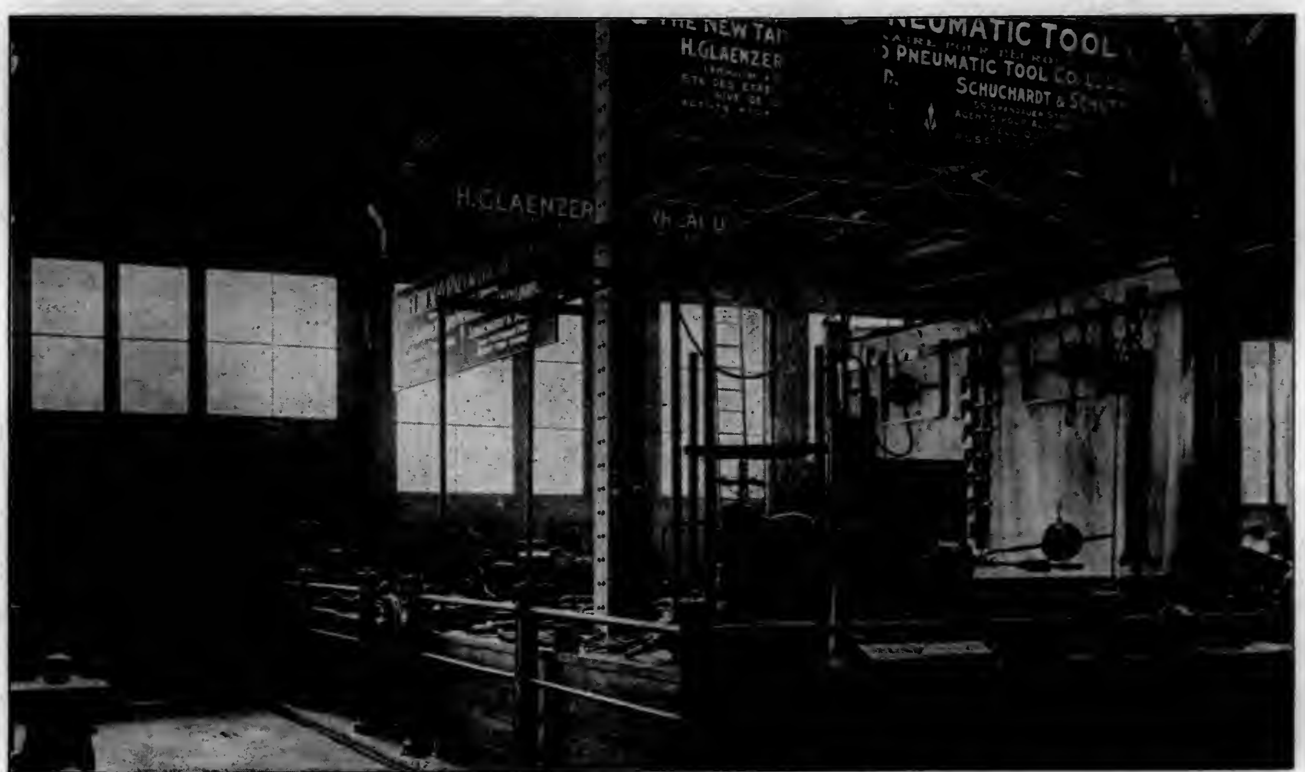

Fig. 1.—Exhibit of the Chicago Pneumatic Tool Companv at Vincennes, Paris Exposition.

Fig. 2.—Full Size Section of a Steel Ship, Illustrating Use of Pneumatic Tools.
Exhibit of Chicago Pneumatic Tool Company, Paris Exposition.

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The fastest of the trains classed as "light" is on the Philadelphia & Reading between Philadelphia and Jersey City, making the 90.2 miles at 58.2 miles per hour, including 7 stops. The next best (and best long distance) run is that of the New York Central "Empire State Express," making 444.6 miles at 53.9 miles per hour with 4 stops. Deducting stops, the speed is 54.3 miles per hour. The Burlington stands next with a run of 206 miles at 53.3 miles per hour and 3 stops.

Under the division of heavy trains the Philadelphia & Reading Atlantic City flyer is the fastest, its schedule being 66.6 miles per hour for 55.5 miles. The "Big Four" has a train making 266 miles at 44 miles per hour with 11 stops, and this is done with one engine. Another long engine run of 309.5 miles without change is reported on the Southern Pacific. Other trains are mentioned and the progress in the past 10 years briefly discussed. Mr. Slack sums up the progress in locomotive construction in this time as follows:

1. The later engines are heavier and more powerful;
2. Boiler pressures have increased and design and construction of boilers improved;
3. The compound engine is being used to a greater extent;
4. The area of heating surface in proportion to cylinder volume has been increased;
5. The capacity of tenders, both for coal and water, has increased;
6. The tendency is to use longer piston strokes;
7. The use of piston valves is increasing.
8. Higher piston speeds are used.

A cost of $4.32 for driving all of the rivets, 253 in number, in a standard locomotive firebox of the Baltimore & Ohio Southwestern Railroad is a noteworthy and remarkable result. This work was recently accomplished in nine hours at a cost of 48 cents per hour, with a long-stroke pneumatic riveter made by the Chicago Pneumatic Tool Company. The same work formerly required 15 hours of hand labor, at 73 cents per hour, giving a total cost of $10.95 for hand work. If done by hand snapping, it required 12 hours and cost $7.56, at 63 cents per hour. Pneumatic tools in this case, therefore, saved $6.63 over hand riveting and $3.24 over hand snapping, the figures referring to labor charges only. This is not its only saving, because the greater rapidity of the work results in less delay in the boiler shop, and consequently increases the capacity of the shop. Because of the fact that the boiler shop is often the slowest part of locomotive plants, and also because of large amount of space required for boilers, the question of time in the boiler shop is exceedingly important.

Our attention has been called by Mr. Geo. H. Daniels to the fact that two tickets were recently purchased at the New York Central ticket office in Rochester for Kobe, Japan, a distance of 8,833 miles. The trip requires but three changes, one at Chicago, one at San Francisco and one at Yokohama. The trip will occupy but 27 days. A short time before, the same office sold a ticket for Christ Church, New Zealand, a distance of 13,000 miles.

CHICAGO PNEUMATIC TOOL COMPANY'S EXHIBIT.

Paris Exposition.

This company had three separate exhibits in Paris, one at the main exposition in the Palace of Electricity and Machinery at the Champs de Mars, and another interior exhibit at cent conventions of mechanical technical associations in this country, but were made much more complete because of their educational value among Europeans. The open-air exhibit at Vincennes contained much of the same machinery, but it was shown in actual service. The second engraving illustrates a full size section of a steel ship, with the keel, frames, plating

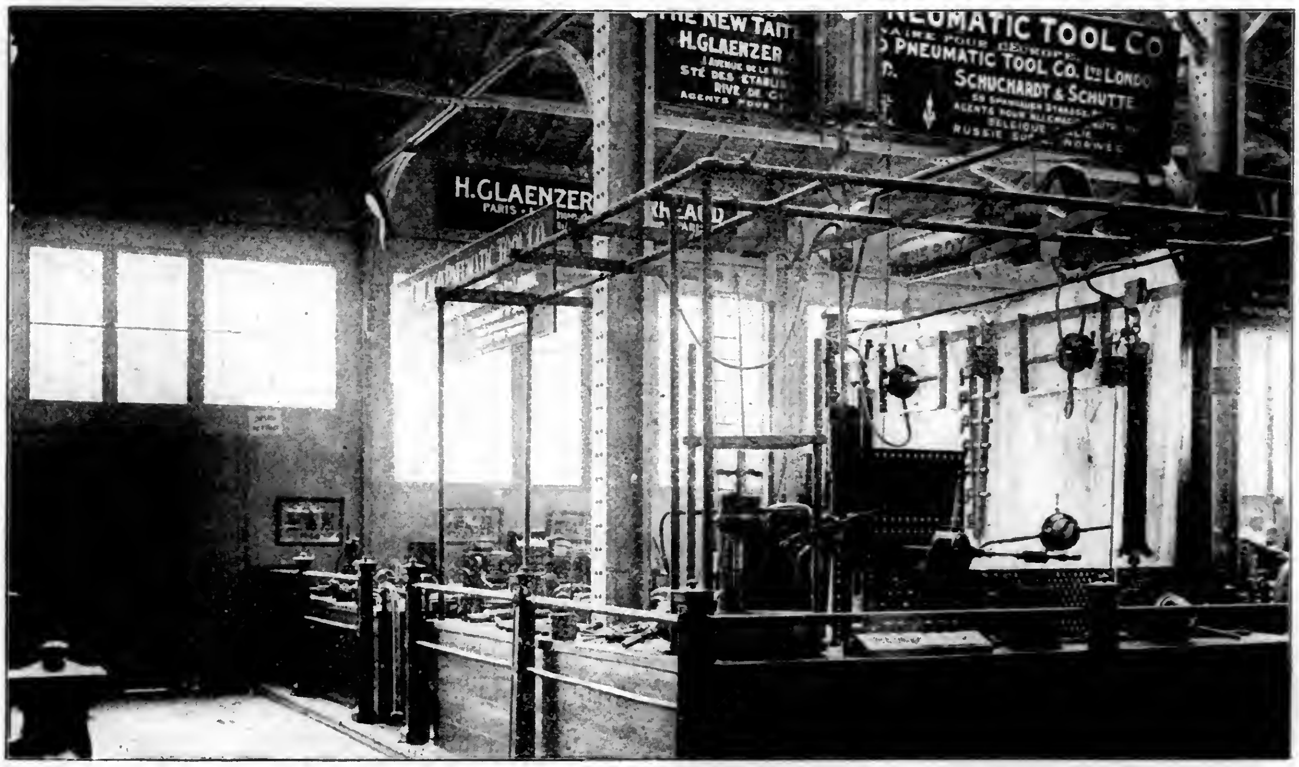


Fig. 1.—Exhibit of the Chicago Pneumatic Tool Companv at Vincennes, Paris Exposition.

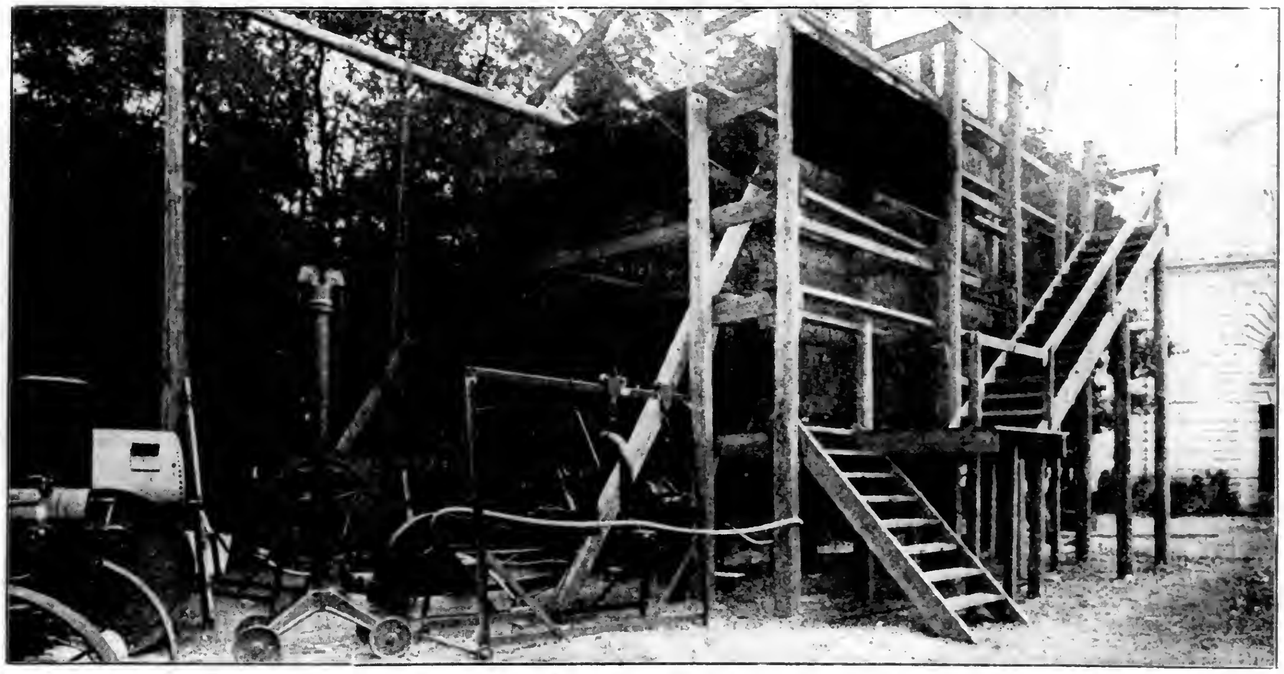


Fig. 2.—Full Size Section of a Steel Ship, Illustrating Use of Pneumatic Tools. Exhibit of Chicago Pneumatic Tool Company, Paris Exposition.

Vincennes, shown in Fig. 1, and a third in the open air at Vincennes, a view of which is given in Fig. 2.

All three were very elaborate and complete, and where possible the devices were shown in operation, special attention being given throughout to illustrate the machines in connection with their direct application to practical work.

The two interior exhibits in general resembled those at reand decks, by aid of which the utility of pneumatic tools in ship building was demonstrated in an impressive way. This plant was operated only during certain specified hours and it developed remarkable interest and large attendance.

In this work the fact of the applicability of one pneumatic tool to various operations was made clear, the long stroke riveter being employed in plate, deck and frame riveting, in

ship construction, and also in general work in connection with yoke frames. The rivets were heated in portable oil rivet heating furnaces, each having a capacity of 500 rivets per hour. This exterior exhibit included air compressors, cranes, plate scaling machines, drills, foundry rammers, hoists, jacks and in fact the entire catalogue of pneumatic devices for work on metal and wood, the chief features being the hammers, drills and riveters. Air was supplied by an independent compressor at each exhibit, and the large outside work also received a supply from the compressor of the exhibit of the Ingersoll-Sergeant Drill Company.

The deck and shell riveter illustrated in Fig. 3 attracted a great deal of attention, as probably one of the most important of recent improvements in ship building methods. A glance at the engravings makes the construction clear and shows the convenience of the device. A long stroke riveter is so mounted in the end of a U-section beam that it may be turned in any direction to reach a rivet. By means of an

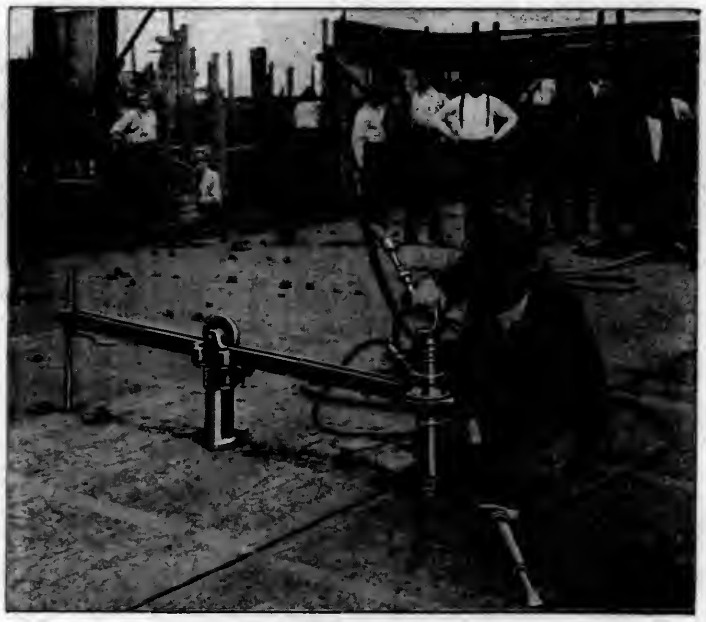


Fig. 3.—Deck Riveter.

adjustable block, the beam is clamped at the middle of its length and the end of the beam opposite the riveter has a support in the form of a rod with a number of grooves whereby an adjustable support of this end may be had by means of a latch. This device renders it easy to reach a large number of rivets with one setting of the central support. The cost is from one-half to one-third of that of hand work. It is done by ordinary labor and renders ship builders independent of riveters' unions.

Other manufacturers of pneumatic tools were also well represented at the Paris Exposition, notably the Q. & C. Company, the Standard Pneumatic Tool Company and others, those mentioned having been in competition for the official awards. The Chicago Pneumatic Tool Company received from the International Jury of Awards a gold medal, and a second gold medal was awarded to Mr. Boyer as collaborator and inventor of the tools, giving the two gold medals to this company, these being the highest awards and only gold medals awarded in this class. A silver medal was awarded to the Q. & C. Company and one of bronze to the Standard Pneumatic Tool Company, the other concerns, which are not as well known, not being in competition.

A combined slotter and planer, the largest in the world, with a stroke of 22 ft. and a slot of the same size, is included in the equipment of the main machine shop of the Newport News Shipbuilding and Dry Dock Company, at Newport News, Va. It is driven by a 50 horse-power individual electric motor.

CONTRACTION OF AREA.

As far as contraction of area as a measure of quality is concerned, it is more and more recognized that its value has been very much overrated. At best it is only an indication of the local condition of the metal at the point of contraction, and the best proof of its unreliability is the fact that Woehler, who is the father of contraction of area as a measure of quality, has abandoned it himself. Professor Martens, on giving official instructions as to tensile testing to all those doing any testing of railroad and other material, makes the following remarks about contraction of area: "Years of experience and very extended investigations have taught that contraction of area is an unreliable measure of quality; more so than elongation, and after some resistance on the part of the originator it was abandoned by him and the most of those who had used it."

If the originator of contraction himself abandons it as erroneous, then we can leave arguing about its value with those who cannot get out of old, time-worn ruts and superstitions.—P. Kreuzpointner, in "Sparks From The Crescent Anvil."

The Schnectady Locomotive Works have about completed a new power house. It is 184 x 77 ft., built of brick and has two chimneys 200 ft. high.

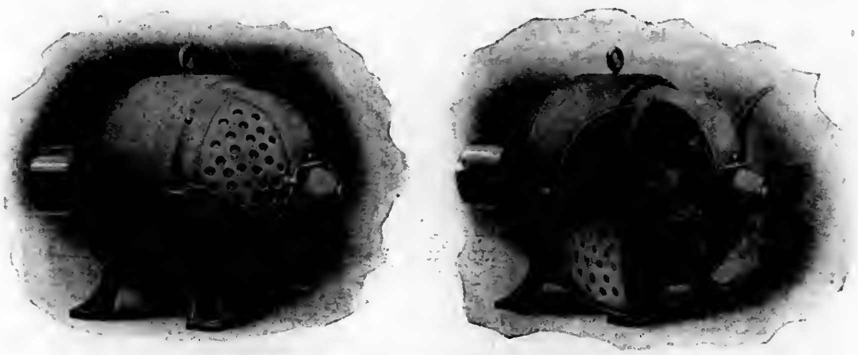
Ten boilers of 300 horse-power each, and one 50 h.-p. engine, will furnish power for the various shops.

Track scales are becoming more important with the general introduction of systems of tonnage rating. It is necessary to keep them in good condition and to test them often. At the recent convention of the Superintendents of Bridges and Buildings a strong argument for better scales was offered. The deck or flush scale is in most general use, but from the experience of the New York, New Haven & Hartford it appears that suspended scales with a housing may be expected to last at least twice as long as the usual construction and at the same time to be more accurate. The housed scales cost more to install and they require more room, but it was thought that their advantages were not generally appreciated or they would be more generally used. The suspended scale does not freeze, its bearings are kept cleaner and offer less friction, and if properly housed there is no deterioration from rust. The committee suggested the importance of using test cars instead of test weights, because of greater accuracy in testing when heavy loads are used. A scale which will weigh a light load correctly will not necessarily be equally accurate with heavy loads. The committee recommended the practice of private firms who test their scales every week.

Compressed air traction seems to be making considerable headway in New York, and after the long experimental work, 28 cars having Hardie motors have been ordered for use on 28th and 29th Streets. We have recorded in our columns the earlier results of the Hardie cars on the 125th Street line, where they had a satisfactory trial for a year. The cars were afterward taken to Chicago for "owl" service at night after the cable was stopped. They were purchased for that purpose and have now been running 16 months. In New York the 28th and 29th Street lines are to be rebuilt for the air cars, and it is stated that the Metropolitan Street Railway Company will order 100 more cars similar to the 28 already mentioned when the first order has been completed. The recent consolidation of the American Air Power Company with the Compressed Air Company of New York places this work all in the hands of a single concern, the Compressed Air Company, and more active progress in air traction matters may be expected. The extent of the order from the Metropolitan Street Railway Company seems to indicate a satisfactory outlook for this branch of engineering.

ENCLOSED MOTORS—THE TRIUMPH ELECTRIC COMPANY.

Electric motors are so generally employed for power distribution in large shops that it is natural to look to see the type which has been adopted when reading of new or rebuilt manufacturing plants and shops. Among the types which may be accepted as satisfactory are those of the Triumph Electric



Enclosed Motors—Triumpn Electric ompany.

Company, Cincinnati, Ohio. This is one of the concerns whose estimates may be considered as guaranteeing good practice based upon sound engineering, extensive experience and reliable workmanship.

This company has recently added a number of improvements to their slow and moderate speed generators and motors. They are designed with special reference to high efficiency with regard to the magnetic circuits, the avoiding of sparking and heating, also the greatest care is observed in construction, not only in the insulation and winding, but in the machine work. All parts are made to gauges and replacements may be easily made. The enclosed motors embody all of the special features of the other Triumph machines. The poles are laminated, the armature iron clad, the brushes are of carbon and the bearings self lubricating. The engravings illustrate their appearance when open and when closed. This type was designed for use in dusty or dirty places, or where there is special danger of dust explosions. The motors may be placed on the floor, wall or ceiling; when placed on the floor a belt tightener is provided in the form of a wooden base. The doors may be wholly or partially enclosed. The covers may be perforated and the holes covered with wire gauze, as is done in the motor illustrated. This design is remarkably neat and attractive, yet the construction is such as to insure ample strength. This company makes direct-connected and belted generators, belted motors and motors for elevators and direct-driven machinery.

THE BAUROTH GAS ENGINE.

Gas engines, while differing widely in theory of action and construction, have one common feature, that of obtaining power from the heat of the working fluid without the use of a furnace or boiler, and the many advantages of these internal combustion engines have led to their use on the larger railroads of this country, in place of steam plants, in pumping stations and are found to save annually at least 25 per cent. in cost of fuel, besides a saving in attendance.

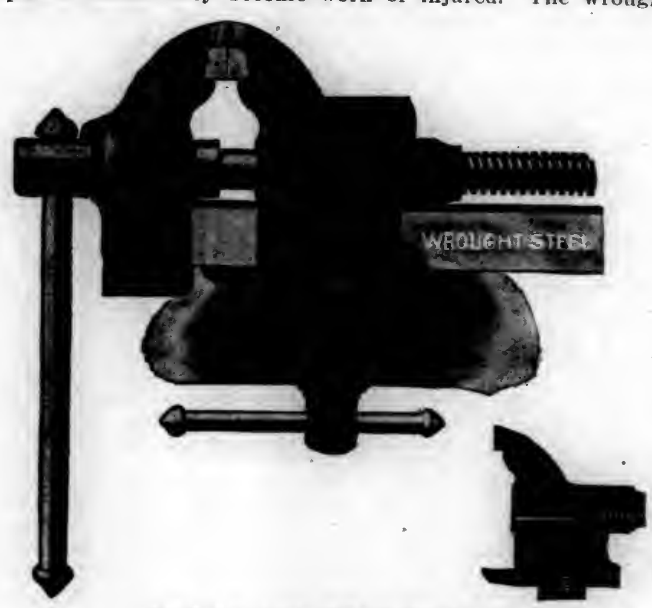
W. F. Bauroth & Bro., of Springfield, Ohio, are manufacturing a gas engine on the four-cycle principle which is designed for the greatest amount of hard service and with the fewest number of parts and is well adapted for railroad work. The bed has large bearings, while the crank-shaft and connecting rod are made of the best open-hearth steel forgings. The igniter is thoroughly positive and very simple. The time of ignition may be changed to accord with the speed, so that in starting there is no danger of having the explosions occur prematurely and consequently cause "back firing." The governor is of the pendulum type and is connected direct to the gas valve, and regulates the supply so that a full charge or none at all will be taken into the cylinder in proportion to the work being done. It is very simple and sensitive and maintains the engine at a uniform speed. Tne speed may be changed while the engine is in operation. There are but two principle valves, namely, the inlet valve and the exhaust valve, and these valves are of the well-known poppet type, which has always given perfect satisfaction. The pressure on the exhaust valve, due to the compression firing the charge, is relieved by the auxiliary exhaust port to such an extent that expensive and complicated mechanism for lifting the exhaust valve under pressure is done away with. By the introduction of an auxiliary exhaust port, the products of combustion are largely permitted to pass out of the cylinder without forming a crust about the exhaust valve and upon its seat. The seat is thus kept perfectly clean and bright, and consequently there is no necessity for frequent regrinding. The gas valve and gasoline pump are in line with the inlet valve, so that a perfect mixture is always assured. Either gasoline or gas may be used and the engine may be changed from one to the other while in operation.

STEEL BAR VISE.

Manufactured by Merrill Bros., Brooklyn, N. Y.

From the wide experience of the Merrill Bros. in the manufacture of vises for use in railroad shops, that will stand the wear and tear of hard work, the steel-bar vise shown in the engraving is the outcome.

The jaws being extra heavy, cannot be broken with a hand hammer, making it an excellent chipping vise. They are faced with carefully tempered tool-steel pieces, which can be easily replaced should they become worn or injured. The wrought



Steel Bar Vice—Merrill Brothers.

bar is machined perfectly square and parallel and is well fitted into the pocket in the back jaw.

It will be noticed that the plain part of the screw extends well into the back jaw, which enables the vise to be opened far enough for ordinary use before the thread is exposed. The screw is large in diameter, with a strong, square thread, well fitted into the back jaw, the threaded part (or nut) being as long as the jaws are wide.

The vise swivels on a large washer and can be turned to any position and securely held there by the bottom screw.

For straightening rods, etc., the anvil at the back will be found very useful.

BOOKS AND PAMPHLETS.

A Hand-Book of the Electro-Magnetic Telegraph. By A. E. Loring, a Practical Telegrapher. Fourth edition, revised. Published in Van Nostrand's Science Series, by D. Van Nostrand Company, New York, 1900. Price, 50 cents.

The principles of the electro-magnetic telegraph have been presented in this little book in a very clear and concise manner for the use of practical operators and students of telegraphy. While the work does not go deeply into the subjects treated, it will nevertheless be found a great help to those who wish to take up higher and more complete works on electricity and telegraphy. The chapters on electricity and magnetism, the Morse telegraph, the duplex and quadruplex methods of telegraphy, practical telegraphy and the construction of lines, show the general character of the subjects treated. The book also contains a helpful appendix of suggestions and exercises for learners.

Engineering Studies. Part II. Roman Stone Arches. By Charles Evans Fowler, M. Am. Soc. C. E. New York: The Engineering News Publishing Co., 1900.

This pamphlet of 16 pages contains excellent photographs of famous bridges built so long ago as to cause surprise and wonder at the engineering and scientific knowledge which their designers and builders must have possessed. They are presented as studies in engineering, the author giving a few brief paragraphs of information and comment upon each structure. The subjects are: Old Roman aqueducts, bridge of Saint Angelo, bridge of Augustus at Rimini, bridge of Alcantara, the bridge of the Rialto, the Pont du Gard at Nimes, the bridge of the Trinity, Florence, and the Canal Regio bridge at Venice. The author expresses appreciation of the skill of the builders and directs special attention to the beauty and art in these works. The pamphlet is well printed and shows good taste in every way. The reader who has not seen a collection of good photographs of these magnificent structures will spend a long time profitably in studying them. Probably the deepest impression received will be the wisdom of permanence in engineering construction and with this the desirability of combining art and beauty with strength and durability in structures which are intended to last.

Mechanics Applied to Engineering. By John Goodman, Professor of Engineering in the Yorkshire College, Leeds. Published by Longmans, Green & Company, 39 Paternoster Row, London, 1899; 605 pages; illustrated.

This book is altogether one of the best works on applied mechanics for the use of those engineers and students who have a good understanding of the theory of mechanics and elementary mathematics, but little or no knowledge of the elements of calculus, that we have seen. The author has stated in a systematic and as concise a form as possible the principles involved in applying such knowledge to engineering problems. The first three chapters are devoted to definitions, formulae and explanatory matter, which is very essential to a good understanding of the subject. A work of this kind, in one volume, must of necessity be brief in its treatment, but in some instances the explanations are unduly short, and unless the book is used in connection with other reference books on the various subjects treated, the student is apt to be led into trouble in attempting like problems by what may seem to him correct methods. The chapter on mechanics is very short, but with these exceptions the author has shown careful consideration of his subjects as to the space given them. The book is well illustrated with 620 engravings, and many helpful notes are contained in a carefully arranged appendix. The use of calculus has been avoided as far as possible, and appears only in the chapters on Mensuration and Moments, where it is used very sparingly, and is supplemented by an elementary treatment of the operations of differentiating and integrating in the appendix, which will serve to show that a knowledge of calculus sufficient to solve practically all the problems a person is likely to come across can be acquired in less time than is spent in dodging it by round-about methods. The book will also prove useful to those preparing for examinations to the Science and Art departments and the City Guild's technical examinations, for which it was mainly designed.

"Engine Tests, Embracing the Results of Over One Hundred Feed Water Tests and Other Investigations on Various Kinds of Steam Engines, Conducted by the Author." By Geo. H. Barrus. Pages, 349; illustrated. Published by D. Van Nostrand Company, New York, 1900. Price, $4.

Those who have the book "Boiler Tests" by the same author will at once understand the purpose of the present work with the explanation that it follows the same general lines as the earlier one. Mr. Barrus has collected a very large number of engine tests made by himself under working conditions, and while it was impossible to always secure the refinements of laboratory tests, the fact that these were all made in commercial practice makes up for such deficiencies. The book is more than a mere record of figures; it also presents the author's comments and comparisons. It appears to be of special service to engineers in designing new power plants or reconstructing old ones, because it shows within rather wide limits what designs and what practice should be used and what avoided in order to secure the best results. Part I is devoted chiefly to explanations of the methods of making the tests and the manner of working up the results. It has chapters on indicating, measurement of feed water, leakage tests and calibration of instruments. Part II presents tables of tests of simple, compound and triple expansion engines, feed water tests and a review of the feed water tests with concluding chapters on valve setting and steam pipe diagrams. The latter are curious and they do not seem to follow any rule or indicate a law. The author's comments upon the effects of pressure, speed, condensing and superheating upon economy are specially interesting, and these, together with his opinions of the relative economy of the different types of engines, constitute the most valuable part of the work. In the comparisons it is made clear that the author has in all cases given due weight to the differences in the conditions which influence his opinions, and this is most important in comparisons of this character. Not the least valuable characteristic of the work is the absence of all indications of favoritism toward any particular type or condition of operation. We are glad to have it as a reference book; it is not disappointing in any particular. The simplicity of its style is commendable and we should say that steam users and prospective engine purchasers, as well as engineers, will find it exceedingly useful.

POOR'S MANUAL FOR 1900.

Poor's Manual for 1900 has been received and it is of unusual interest this year. The length of railroads completed on December 31, 1899, is stated to be 190,833.41 miles, traffic statistics and earnings being given for 184,178 miles. During the year 1899, 3,981.36 miles were built. The introduction opens with a general exhibit for the fiscal year 1899, including comparative figures for a number of years. Previous volumes of this colossal work have included valuable discussions of statistical subjects, but we have not seen anywhere such a comprehensive review of the progress of railroads as the editor presents in this introduction in the form of an 89-page chapter, entitled "A Study in Railway Statistics." It follows the tables with which the record is brought up to date. This is a review of the statistics of development and finances of the railroads of the United States, with special reference to the period from 1880 to 1899. This review is particularly appropriate at the approaching end of the century in view of the wonderful development of the resources of this country. Brief notes will serve to indicate the character of this masterly review.

In 1826 steam was first applied on the Stockton & Darlington Railway. In 1840 there was in New England a well-defined system of railroads. A number of tables give the location and mileage of all the roads in operation in various sections of the country at that time. The recognition of the superiority of rail over highway transportation immediately resulted in a large number of schemes which were fostered under our peculiar political organization, but up to 1848 progress in construction was slow, although it absorbed all of the floating capital of the country. The discovery of gold in California led to the first great movement in railroad construction and its effect upon industry and commerce was prodigious. It was without precedent in history. Up to 1848, 5,996 miles had been completed, and in 1860 it had reached 30,635 miles, an increase of 400 per cent. Lake Erie was next reached and

lines pushed on to Chicago in 1853. In 1847 the Pennsylvania Railroad began, and was opened in 1854. Tables give the terminal points and lengths of the first road built in each State, and the date of opening. During the civil war, mileage fell off considerably. The resumption of specie payment in 1879 gave an impulse to railroad construction never before experienced anywhere in the world. Mileage increased from 93,262 in 1880 to 166,654 in 1890, an increase of 80 per cent. The Union Pacific was completed in 1869, which was also the date of the beginning of construction of the Northern Pacific and the opening of an important period. Railroad construction has proceeded in great waves and in recurring periods it became the absorbing passion of the people. There are discussed by the editor also the subjects of consolidations, systems, formation of trunk lines, capitalization and finance. One needs to study this discussion in order to appreciate the influence of our railroads; we can give but a fragmentary review of such a work.

The most important new feature introduced into the Manual in recent years is one first presented in this year's edition and is entitled a "Ready Reference Bond List," and covers 86 pages of the Manual—from 1296 to 1381, inclusive. Its distinctive features are, (1) showing amount of annual charge on each issue; (2) arrangement of dates of interest payments, which in addition to giving for each separate road the usual data, enables a bond clerk to run down any column, say that headed "JJ," and ascertain at once all railroad coupons that fall due on the first of January or July; (3) "Property Covered," giving the terminal points and mileage of the lines covered by each separate mortgage, together with the average amount (in dollars) of bonds outstanding per mile of railroad, and (4) the names and addresses of the Trustees for each mortgage.

The Manual for 1900 covers 1954 pages, of which 987 pages are devoted to the presentation of the statements of 2,026 steam railroad companies; 209 pages are devoted to the statements of 1,132 street railroads and traction companies; 84 pages are devoted to the statements of 166 leading Industrial Corporations, and 132 pages are taken up with the Department of State, City and County Debts, covering the affairs of 367 corporations.

Interstate Commerce Commission.—The proceedings of the twelfth annual convention of Railroad Commissioners, held at the Pfister Hotel, Milwaukee, Wis., May 28 and 29, 1900. Bound in cloth.

Data for Designing Bridges.—Messrs. Waddell & Hedrick, Kansas City, Mo., have issued a little pamphlet which puts in convenient form the data required to make the best and most economical design for railway bridges and trestles. It will be found useful to railroad men who have occasion to make contracts for such structures. After each question are blank lines for convenience in filling in the desired information. Copies of this pamphlet can be obtained by addressing the office of that firm.

Souvenir of the Victoria Bridge.—The Grand Trunk Railway has prepared a handsome and appropriate souvenir of the Victoria Jubilee Bridge across the St. Lawrence River at Montreal which was opened for traffic December 13, 1898. The new structure was found necessary to take the place of the famous old Victoria Tubular Bridge, which was put into service in 1859, and with the new structure the capacity for traffic of the Grand Trunk at this point is enormously increased. It is interesting to note that the old bridge was 16 ft. wide and 16 ft. high, with but a single track. The new one is 66 ft. wide and from 40 to 60 ft. high. It has double track, roadways and footways and cost but $2,000,000, as against $7,000,000 for the original structure. The souvenir is handsomely illustrated, well printed and bound in hinged aluminum covers. It is a fitting record of this interesting structure. We presume it was prepared under the direction of Mr. W. E. Davis, Passenger Traffic Manager of the road, to whom we are indebted for a copy.

Ball Bearings.—The Ball Bearing Company, of Boston, Mass., have just sent a new issue of their twentieth century catalogue of ball and roller bearings for all kinds of machine construction, shafting and vehicles. This book illustrates in addition to their ball thrust collar bearings, hub patent thrust collar bearings, grooved ball end thrust bearings, thrust collar roller bearings and grooved ball shaft bearings, their large variety of ball bearings for light and heavy vehicles, swivel axles and bearings for automobiles. It also contains tables of sizes and maximum loads for each style of bearing, together with a list of prices. This catalogue can be had by addressing the main office of this company at Watson Street, Boston, Mass.

The life of crucibles used for melting brass is usually short. The service is severe and only the best of them will last more than a comparatively short time. Our attention has been attracted to the fact that a graphite crucible was recently used at the foundry of the Magnus Metal Company for 34 heats, when it became too thin for further use, but up to that number of heats it had not cracked. Another example of long use occurred recently at the works of Pattin Brothers & Co., Marietta, Ohio, where a crucible went through 42 heats. These were Dixon graphite crucibles made by the Dixon Crucible Company, Jersey City, N. J. Mr. George Couter, foreman of the brass foundry of the Kansas City, Pittsburg & Gulf Railroad, describes a still better experience. He says: "I have a Dixon crucible from which I have taken 45 heats of phosphor bronze. It is a No. 50 crucible and the furnace has natural draft. In the last heat I melted 140 lbs. There are no cracks in it. I am afraid to use it again on account of its being thin."

Mathematical and Surveying Instruments.—Keuffel & Esser Co., New York, has just issued their new catalogue of drawing materials, mathematical and surveying instruments. This new edition is considerably enlarged. The descriptive matter has been elaborated and made more complete, many cuts have been added and others replaced by better ones. Of the several additions to this book we notice a greatly improved assortment of slide rules, new planimeters and pantographs, which are now listed in a heretofore unattempted manner. Fine narrow steel tapes are shown in an increased variety, with the reels listed separately to allow of greater latitude in selecting. Current meters, hook gauges, tide gauges, aneroids, barographs, thermographs and hygrographs have been added, and of sextants and octants there is a new list. The assortment of drawing instruments, scales, drawing tables, etc., has been considerably enlarged and profile and cross-section rulings on cloth have been added, thus making this catalogue of mathematical and surveying instruments one of the most complete that we have seen.

Pan-American Exposition.—Up to the present time the descriptive matter bearing directly on the Pan-American Exposition has been confined to certain features of the Exposition, as they have been developed. The booklet which has just been issued by the Bureau of Publicity of the Pan-American Exposition gives a very comprehensive idea of the character of the Exposition, which is to celebrate the achievements of civilization in the past 100 years of development in this hemisphere. The 20 or more structures which will surround 33 acres of court settings will be for the exhibits brought together from all parts of the Western Hemisphere and from the island possessions of the United States. The exhibits of other countries will, of course, not be included, as the Exhibition is for all Americas, as the prefix Pan means. The total cost of the Exposition, exclusive of exhibits, is now estimated at $10,000,000. Of this amount about $3,000,000 will be expended upon the Midway. The sum for the Midway is more than the total cost of some very pretentious expositions, so that by comparison one may gain a very fair idea of the work which Buffalo is carrying rapidly to completion. A beautiful landscape comprising 350 acres, half a mile wide and a mile and a quarter long, is devoted to this wonderful enterprise. The gates of the Exposition will be opened from May 1 to November 1, 1901, and Buffalo, a very delightful city of nearly 400,000 population, with its nearness to Niagara Falls, where unlimited electric power may be had for decorative purposes, will attract millions of people next year and outshine all former undertakings of this nature.

The Joseph Dixon Crucible Company, Jersey City, N. J., have issued a folder concerning the remarkable durability of their silica graphite paint. A photograph is shown of the Park Street bridge of the Cleveland, Cincinnati, Chicago & St. Louis Railway at Cincinnati, Ohio, the girders of which are exposed to the fumes and smoke of 500 locomotives every day. It was painted with Dixon's silica-graphite paint five years ago and the action of the fumes have been successfully resisted for this long period. The folder also contains a statement from Mr. J. Y. Hill, Roadmaster of the Southern Railway, made before the Association of Railway Superintendents of Bridges and Buildings, expressing satisfaction with the covering qualities and appearance of this paint. The company invites correspondence with reference to time records in all climates.

EQUIPMENT AND MANUFACTURING NOTES.

Berry Brothers, of Detroit, believed to be the largest manufacturers of varnish in the world, have decided to enter the railroad field and develop that branch of their business systematically.

The Standard Steel Platform is now in use on one hundred railroads throughout the United States, Canada and Mexico, which shows a very steady and remarkable growth in popularity since its first introduction to the railroads in 1897.

The Rand Drill Co. has removed its main office from 100 Broadway, New York, to the fifteenth floor of the new building just erected by the American Exchange National Bank, at 128 Broadway, corner of Cedar Street, to which place all future correspondence should be addressed. In its new office, the company will occupy the entire floor, in conjunction with its allied interests, the Pneumatic Engineering Co., the Rendrock Powder Co. and the Davis Calyx Drill Co.

Pneumatic hammers are gaining ground rapidly in their application to riveting. The Riter-Conley Manufacturing Company are using the long-stroke 13/16 by 9-in. riveting hammer of the Chicago Pneumatic Tool Company at the Laughlin Furnace, Pittsburg, with effective results in very difficult service. They rivet three 1-inch plates with 1⅛-inch rivets, and with hand work the ratio of loose rivets was 4 in 12, while the pneumatic riveter drives them four times as fast and with a ratio of one loose one in 18, a remarkable performance under the circumstances.

Mr. E. H. Talbot, formerly Editor and Proprietor of the "Railway Age," has established a bureau in Mexico for the benefit of American interests. The business is conducted under the firm name of Talbot & McCauley. It includes a permanent exhibition of American products, salesroom and information bureau. Mexican investments and business interests, government concessions and contracts will be negotiated. Mr. Talbot's wide acquaintance in both countries should make this a profitable and successful undertaking. The offices and permanent exhibition rooms are in the Centro Mercantil Building, City of Mexico, facing the National Palace.

At the national convention of Railroad Commissioners held at Milwaukee some very interesting reports from the various committees that had been appointed the year previous were presented and adopted. Among them were papers on "Classification and Construction Expenses of Steam Railroads," "Delays Attendant Upon Enforcing Orders of Railroad Commissioners," "Legislation," "Uniform Classification" and a very important report on "Safety Appliances." In this paper some excellent recommendations were made which were adopted by the convention. The question of car lighting was dealt with in a report as follows: "The Pintsch gas light system is another improvement rapidly coming into general use. Its great advantages are most highly appreciated by the public, and its adoption, wherever practicable, should be required."

The award to the Triumph Electric Co., manufacturers of electric light and power machinery, Cincinnati, Ohio, of a medal at the Paris Exposition for their well-known machines, came as a complete surprise to them, for they were not direct exhibitors at the Exposition. Their machines on exhibition there were loaned to the Fay & Egan Co., the Ferracute Machine Co. and the R. K. Le Blond Co. for operating their exhibits. The Triumph Electric Co. were not competing for a medal, not being direct exhibitors, and of course they naturally feel highly complimented that the machines attracted so much attention.

The preservation of wood from rotting and decay has occupied the attention of engineers for many years. A number of well-known processes have been developed and used long enough to show the possibilities in this direction, but the cost of their application has always been a serious obstacle. Our attention has been drawn to what is known as Royal Wood Preserving Oil, a preservative for which excellent results are reported and one which is applied externally with a brush, the consistency and specific gravity of the liquid being such that it rapidly permeates the fiber. This preserver, while not closing up the pores of the wood, appears to act in such a way as to exclude air and moisture. It also has antiseptic properties, whereby the albuminous parts of the wood are coagulated and the germs of decay and fungus growth are destroyed. It is stated that wood treated with this preserver is also protected from the toredo worm. The effect of the preservative upon the wood itself is to give it increased resistance against wear and tear, warping and shrinking. Its covering properties are as follows: One gallon will cover 300 sq. ft. of dressed lumber, 250 sq. ft. of rough lumber, 100 sq. ft. of shingle roof and a second coat if necessary requires but one-fourth of these quantities. It seems to be specially well adapted to stock, refrigerator and flat cars; railroad ties and trestles, bridge timbers and piling, telegraph poles and cross arms; boats, barges and wharves; tanks, windmill towers and derricks and for all purposes requiring the use of wood below ground, or in other locations having poor ventilation. The material is manufactured and sold by the Royal Wood Preserver Company, 5 South Levee, St. Louis, Mo.

Early in October the writer thoroughly enjoyed the view along the Susquehanna from the observation platform of the "Black Diamond Express" of the Lehigh Valley Railroad, and those who have not taken this trip across Pennsylvania on this train are advised to do so. This is one of the trains which gives this country its reputation for comfort, elegance and luxury in traveling and the scenery justifies all that has been said of it. There is scarcely an uninteresting mile between Buffalo and the New Jersey flats. The passenger department, under the direction of Mr. Charles S. Lee, General Passenger Agent, has devised a tasteful and artistic brochure, entitled the Lehigh Valley Railroad as Seen from the Train. Copies are handed to passengers and brief paragraphs of information about the country and places passed contribute to the interest of the trip. There are few things left to be desired in traveling on the best of American railroads, and even the chronic grumbler is practically disarmed. To this result the passenger departments have contributed a most important part. They have been largely instrumental in bringing about the present high standard of passenger-train equipment and the development, to a principle, of punctuality, believing that the effect of these factors is to increase patronage by producing satisfactory service and satisfied travelers.

The Rock Island arsenal is to have one of the finest machine shops in the country when the proposed extensions are completed. Specifications and proposal blanks have just been issued for the largest number of machine tools ever purchased at one time in this country. The list embodies 531 items and almost all items include a number of tools. Some of the various machines called for are 218 lathes, almost all of which are to be provided with chucks and various attachments. There are 325 milling machines called for, one item alone calling for 240 machines. A lot of 60 drill presses of various sizes includes an item for 23 three-spindle drills; another for 15 two-spindle presses, and one is for 12 single-spindle machines. The largest single lot called for takes in 83 two-spindle machines, with a working surface of 12 by 15 ins. Of presses there will be 22, this number including almost every type of metal press built. The item of drop hammers alone will run over $50,000, as there are 63 of them called for. They range from 100-pound to 1,500-pound sizes. A great many other items are called for, including machines and machinist tools.

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CONTENTS.

ANOTHER IMPROVEMENT IN STAYBOLTS.

Mr. J. B. Barnes, Superintendent of Motive Power of the Wabash Railroad, has for a long time been at work upon the development of a staybolt to meet the difficulties found in locomotive boiler practice, which do not appear to have been overcome by any attempts thus far made in the improvement of material or in slight changes in the form of the ordinary staybolt. He aims to relieve the staybolts from being strained to the breaking point and to provide for all the movements of sheets relative to each other in such a way as to leave only the tensile strains for the staybolts to carry. He goes a step beyond the ball and socket idea in that he provides for movements of the sheets toward each other. He uses the ball and socket to give flexibility, but provides for a movement of the ball away from its socket. The construction is such as to permit of application to any part of the firebox and to allow of the removal of the bolt itself, in case of repairs, without disturbing the outside cup which forms a permanent attachment to the outside sheet. Mr. Barnes has in mind the stresses in the sheets as well as the staybolts, and he desires to save the expense caused by the failures of both. That of renewing a single staybolt he finds to vary, all things considered, from 30 cents to $10, depending upon the accessibility. His experience appears to show that he has a staybolt which will not break, at least the records of considerable service fail to show a single one broken.

The design is illustrated in the accompanying engravings. The cup is made from bar steel, or it may be drop forged, and screwed into the outer sheet. While it is best to have this cup exactly radial, or in line with the inside hole, it is not imperative that it should be so, as the ball joint under the head of the bolt and the taper hole in the base of the cup will allow considerable more variation than is required for the expansion movements of the sheets. After the cup is screwed into the outside sheet the staybolt is entered and screwed into the inside sheet by means of the square socket tool. A holding-on bar is used on the head of the bolt, while the firebox end is being headed over. The taper plug is then inserted and not only prevents leakage that may escape past the ball joint but tends to spread the cup in the outer sheet and insure a steam tight and rigid joint between the cup and the sheet. If, from any cause it is necessary to remove the bolt, the plug can be screwed out, the inside end of the staybolt chipped or drilled and the bolt removed, leaving the cup intact in the outer sheet. These bolts can be made flush with the outside sheet and be placed behind brackets, expansion plates, air pumps and other inaccessible places.

Ordinarily the custom with the common form of staybolt to offset its weaknesses is to use from 75 to 250 extra bolts to each boiler, these bolts being reinforcements to the ones equally spaced and located at the ends, top corners and back end of the firebox. With the bolt shown no reinforcement is necessary, as no provision is made for broken bolts. Using this design also for radial stays insures the free movement of the crown sheet without cramping the stays or cracking the flue sheet. With the use of this bolt the need for drilled or hollow bolts no longer exists. The staybolt nuisance, according to this experience, may be practically overcome by replacing all broken bolts with the new design or by using the flexible bolts in nests at each top corner of the firebox in the two vertical rows at each end of the firebox and the outside row around the door sheet.

These and other designs of flexible staybolts are sometimes criticised on account of the large holes in the outer sheet. Such criticism might apply were it not for the fact that each staybolt in a firebox forms a separate and distinct brace for the sheets and the pressure upon the firebox sheets transmitted through the staybolts will guard the tensile, as well as the bulging strains, on the outside sheet. Were this not the case how could we reconcile our minds to the single-riveted seams frequently used in the wagon top sheets and back heads. The mere fact that flexible staybolts, requiring these large holes in the outer sheets, have been in use for years with no bad results to the boiler shell would go to prove that the critics' position is untenable.

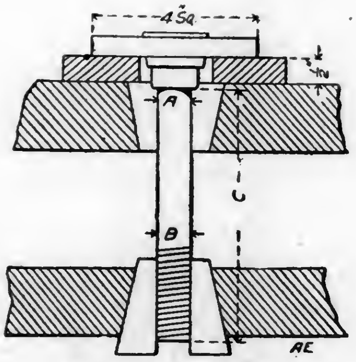
Mr. Barnes has also kindly sent us the records of the destructive tests of three staybolts of this design, the appearance of one of which, both before and after the test, being illustrated in the accompanying wood engraving which was made direct from specimen No. 1, referred to in the record. The tests were made at Purdue University under the direction of Prof. Goss and certified to by Prof. W. K. Hatt. They show an ample margin of strength, and it is interesting to note that the cup, bolt and head are nearly co-equal in strength, a result which must always be pleasing to a designer. Mr. Barnes has a great many of these bolts in use in boilers carrying high pressures as well as others. They are used in all boilers to replace broken ones of the ordinary kind, and there has been no trouble in breakage or leakage, nor has there been any expense for repairs in connection with them. The report by Prof. Goss follows, and it should be noted that the body of the bolt was strained up to its elastic limit before failure occurred.

The plate attached to the flexible joint was supported on the upper end and the threaded end of the bolt was gripped in the wedges of a 50,000-lb. Riehle hydraulic machine, as shown in the sketch. Load in tension was gradually applied until failure occurred. Failure occurred in all cases by the enlarged head of the bolt pulling out from its seat. The results were as shown on page 366.

No. f Bolt.	First Slip.	Maximum Load.	Failure.	Remarks.
1	29,000 lbs.	31,100 lbs.	Head Pulled Out.	....
2	7,[illegible]00 "	27,800 "	"	At 27,000 lbs. bolt began to scale at yield point near wedge.
	31,820 "	31,850 "	"	At 31,000 lbs. bolt began to scale at yield point near wedge.

Dimensions Corresponding with Sketch.

	No. 1.	No. 2.	No. 3.
A	1.08 inches.	1.078 inches.	1.108 inches.
B	0.912 "	1.008 "	1.065 "
C	6.35 "	6.35 "	6.50 "



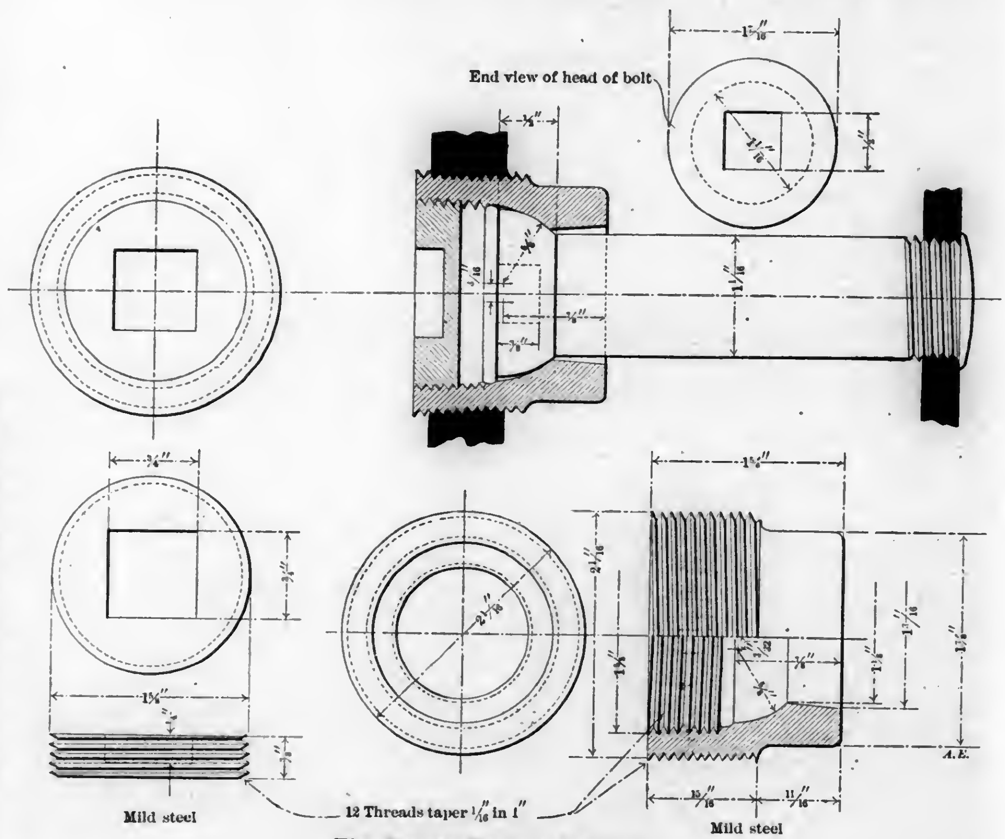
Method of Testing.

In the new conditions brought about by the recent and present unprecedented demands for power, round-house practice has become more important than ever before and the staybolt problem appears as one of the serious difficulties in securing the best use of engines because of the delays caused by it in "turning" locomotives. From this standpoint much may be said. We are now in an age of pooled engines, shortage of power and temptations are strong to depart from the rules which good judgment and safety demand. The staybolt inherited from the earliest locomotives is expected to meet conditions which are entirely new and were never thought of before.

Inspectors who are sure to detect broken staybolts by the hammer test, to put it mildly, are rare, and it is generally believed that the drilling or hollow construction of staybolts meets this difficulty, but even the drilled or hollow staybolts fail at times to indicate when they are broken. It is not unusual to find drilled staybolts broken with no outward sign of fracture. This may be caused by the holes becoming clogged with rust and dirt from the outside or the fractures may be closed up with scale from the water inside. An insight into the roundhouse part of the staybolt question may be had by granting that tell-tale holes will do what they are supposed to do and looking for a moment into the routine of the work of the round-house foreman at a busy terminal.

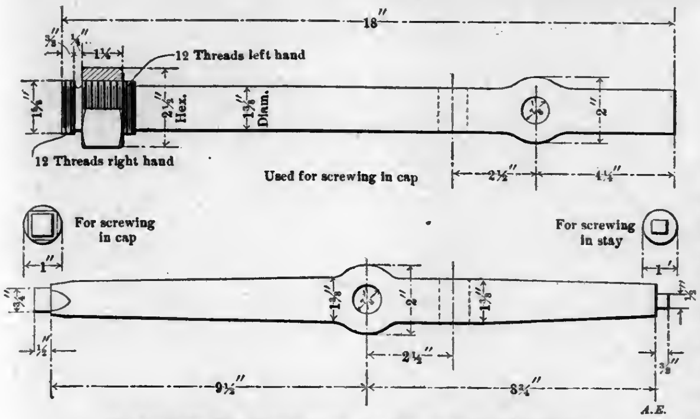
The conditions upon his arrival for the day are discouraging. He is required to accomplish almost impossible tasks with poor facilities. He finds upon his desk the work book, letters and telegrams, recording many troubles. One engine lost time on a passenger train because of foaming. The question is asked why the boiler was not washed out, with an allowance of two hours between arrival and departure from the round-house? Another engine gave up its train because of staybolts and flues leaking. The trainmaster orders an engine to be ready at 8:30 a. m. It is now 7:15 and two broken staybolts are reported on the work book. The boilermaker then reports that another engine, which must be ready in an hour, has three broken staybolts and is squirting water from the holes. No other engines are available, and it is a serious matter to delay this particular train. What is to be done? Simply what is being done every day in the year and on every railroad. The broken staybolts are pened over with the hammer, which stops the leakage, and the proper repairs are deferred until the next trip, when the condition is worse than before, because the broken bolts throw their loads upon their neighbors.

We are forced to the conclusion that compliance with the rules requiring each and every broken staybolt to be renewed immediately would cause a blockade. Nothing more than this is needed to show the advisability of improving staybolts so that they will not break. Those who are in position to know say that this can be and is being done.

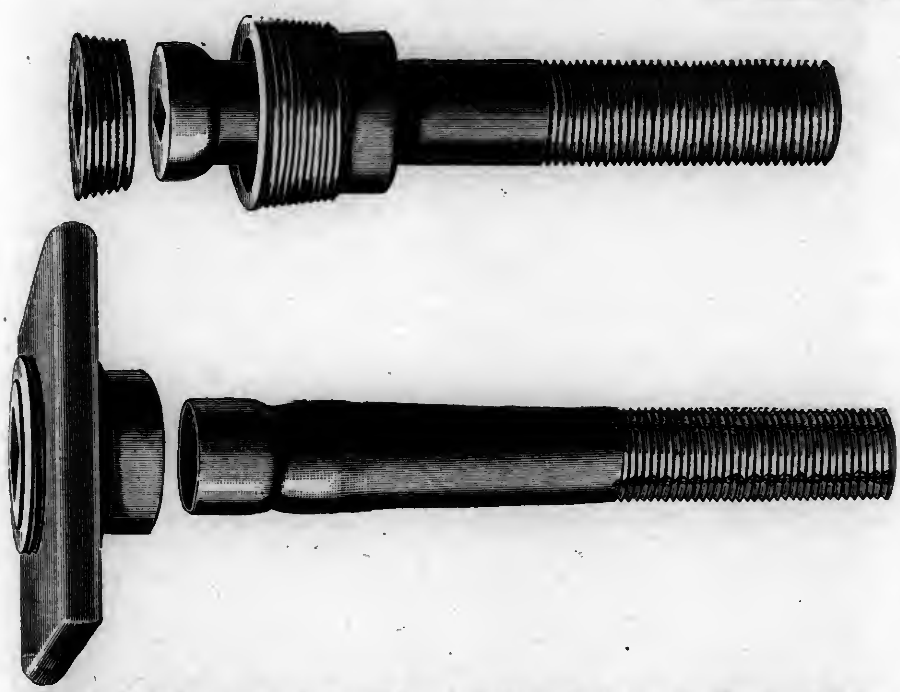


The Barnes Flexible Staybolt.

Mr. Waldo H. Marshall, Superintendent of Motive Power of the Lake Shore & Michigan Southern Railway, gave the second in the series of lectures in the railway course at Purdue University on Thursday, November 1st. His subject was "Locomotive Design." Mr. Marshall first discussed the conditions which control the selection of a type of locomotive which is to render a given service. He urged the importance of making machinery light so that all available weight may be put into the boiler. The possibility of improving present designs by the adoption of steel for wrought and cast iron was carefully reviewed, and examples were given of recent achievements in this direction. In a similar manner, other problems of design which are general in their application, but which readily resolve themselves into matters of detail, were forcefully discussed. Comment upon his remarks concerning care in the design of details to give a handsome appearance to the locomotive and its worthiness of such treatment will be found elsewhere in this issue.



Wrenches for Screwing in Cups and Staybolts.



The Barnes Staybolt—Showing Construction and the Effect of a Destructive Test.

The armor plate difficulty between the Navy Department and the manufacturers has at last been settled. It is reported that the Carnegie and Bethlehem companies have reduced the price of Krupp armor plate to $420 per ton. This will affect 14 vessels and the contracts now standing will involve about $14,000,000.

The embarrassment caused by the shortage of freight equipment, particularly freight cars, appears to be growing worse instead of better. Ever since the car famine struck the Northwest it has steadily been spreading out in all directions until now it affects the whole country. Many remedies have been suggested, but the railroads have not been able to hit on any one plan. The roads have been enlarging their equipment both in number of cars and in capacity, but the periodical demands for rolling stock to take care of the available business is more than they can keep pace with. The question of side-tracking the excess rolling stock in times of decreased traffic is also one to be considered by the railroads, as this means a loss during the time of idleness, besides deterioration of equipment. The demand is at present being met in a way, by loading the cars to their utmost capacity, but in no case is excess loading permitted.

The Central Railroad of New Jersey has begun improvements at its Jersey City terminal which will cost about $100,000. They are in the form of increased facilities.

WHAT MOTIVE POWER OFFICERS CONSIDER IMPORTANT.

(Continued from page 337.)

Lubrication methods are now given more attention than ever before. It is a serious matter to delay traffic by hot bearings, and with conditions which cause the trouble increasing in severity, as they are, the subject is worthy of all the thought that is given to it. The article in our October number upon lubrication from the standpoint of fluid pressures has attracted a great deal of attention. It will, undoubtedly, lead to experiments on a number of roads with oil grooves in the sides of driving boxes, and the closing up of the oil holes and cavities in the tops of the bearings. The lubrication question was brought up in nearly every interview and was mentioned oftener than any other subject.

Flanges on all driving wheels of locomotives of all classes seems to be the rule almost everywhere. Flanges were omitted originally in order to reduce curve resistance and avoid the cutting of tires, but these are really made much worse by throwing all of the grinding upon a smaller number of flanges, which is just what the blind tires do. But when the wheels are all flanged something must be done to give the necessary lateral motion to allow for the effects of curvature. This is done in various ways, by setting the tires in toward the center of the track, making the gauge of the central wheels of 10-wheel or consolidation engines narrower than the standard, by setting the tires to the standard distance and paring down the flanges where they bear against the rail or by setting the tires of the middle wheels at somewhat less than the standard distance and leaving them standard as to contour but giving the wheels sufficient lateral play to accomplish the same result as the other methods. On the Lehigh Valley ⅜ in. lateral play is allowed. On engines of about 15 ft. wheel base the tires of the middle wheels are set 53¼ ins. This, with the amount of lateral play mentioned, appears to solve the difficulty. No flanges are cut, the engines curve easily and the driving wheels do not bend or cut their hubs. If, however, with the other conditions, as stated, the lateral play is confined to ⅛ in. on each side or ¼ in. total, the entire ⅜ in. clearance will be taken by the engine in the form of cutting and grinding in a single trip from Easton to Wilkesbarre.

A system of indexing and filing important articles on motive power subjects was found in three different drafting rooms. In one of them, the Buffalo, Rochester & Pittsburgh, where new shop plans are under discussion, was found an abstract of all of the descriptions and discussions of the arrangement of shops which have appeared in the leading railroad papers for several years. It was condensed to the last degree and covered the principles of modern shop arrangement in a most convenient form. The chief and only wide difference of opinion seemed to be with reference to the location of the tracks, whether transverse or longitudinal, a question which is by no means settled. The indexing referred to consisted in placing upon cards, alphabetically arranged, titles and notes whereby important articles may be easily found and their character noted beforehand. Railroad technical periodicals are thus made easily available and their value as a permant record increased. This practice is worthy of encouragement and development, for such an index may be made an important labor-saving device.

On many roads it is customary to supply each engineer with

an individual set of oil cans, with a view of easily keeping account of the oil consumed. As the number of engineers is usually greater than the number of engines, a large number of cans are required. Mr. G. R. Henderson, of the Chicago & Northwestern, has recently put into practice a simple plan which seems to be a great improvement upon the one referred to. Oil cans enough for all engines are furnished and when an engineer reports for duty he receives full cans which he takes to the engine. Upon his return the cans are again filled and he is charged with the amount of oil required to fill them. This method releases a large number of cans which are held in the storehouse until needed for replacement. With this plan the engineers are not bothered to store their own cans and by using a smaller number it becomes easier and less expensive to improve their quality.

Almost any new device applied to a locomotive may be made to show a saving in fuel if it has the fostering care of the inventor or of some officer interested in its success. It is, in fact, difficult to ascertain the value of a change or improvement unless it is applied and managed in such a way as to place it upon its own merits from the start. When new practice is tried it should be subjected not only to the best men, but also the poorest, because general use will embrace the work of all. The usual manner of treating the compound locomotive may profitably be considered in this connection. The Wabash Railroad recently received eight compounds from the Richmond Locomotive Works, four from the Rhode Island and three of the Vauclain type from the Baldwin Locomotive Works. They were all placed in service without in any way indicating that any officer of the road was specially interested in their success more than was usual in any new design. The engines were pooled with others, and in spite of a strong prejudice against them on the part of some of the operating officers it was soon discovered that by reason of the possibility of using high-pressure steam in the low-pressure cylinders at critical points they were able to haul more cars than the simple engines of the same boiler capacity and approximately the same weight on driving wheels. This settled the question with the operating department. The engineers and firemen also became interested in the compounds when they noticed that less coal and less water were required for them and now the men try to get the compounds whenever there is an opportunity for choice. This is one of the best testimonials for compounding that we have seen. It is genuine, natural and an important recommendation, for the men who handle locomotives are critical even to extremes. When inquiring as to the matter of repairs we are told that these compounds are in the shops less than the corresponding simple engines. By this plan the Wabash has most valuable information concerning this type, and it is understood that all new devices and improvements are subjected to the same treatment, this being a searching test which is sure to expose weaknesses or deficiencies when these exist.

That the capacity of draft gear as usually constructed is not believed to be sufficient for the conditions of service with modern powerful locomotives is indicated by the fact that on more than one drawing table designs for tandem and twin-spring arrangements were found. Another design employing an ingenious arrangement for increasing the effectiveness of springs without increasing the spring capacity, which was not completed, indicated a desire to secure increased resistance to the pulling and buffing stresses without increasing to a corresponding degree the recoil of the draft rigging and the consequent danger of breaking the trains in two. This is a step in the right direction. It is a difficult result to reach with a simple construction using a small number of parts, but it needs no argument to prove that a departure from usual construction is necessary.

The presence of the Westinghouse friction draft gear in a number of the shops visited indicates an appreciation of the necessity for better protection of cars and tenders from the excessive shocks of modern conditions of train service. The devices were usually seen in roundhouses and were intended for application to tenders. This is an excellent place to try the gear, for the shocks become greatest at the tenders of heavy engines, and experience at this point is sure to indicate what may be expected in other parts of the train. It is not only the repairs of the draft gear itself that this device overcomes, but also collateral damages to the entire end structures of cars, and in addition to this the destructive wrecks, due to broken trains, are practically prevented. Recent tests with long trains of steel cars and the heaviest of locomotives, carried out on the Bessemer road, indicate the extreme difficulty of breaking trains in two, even when the train crews systematically try to do so by setting a number of brakes at the rear of the train and deliberately put the entire power of their heaviest engine into a jerk test. We congratulate those who are taking up the subject of improved draft gear. It appears to us to be the most important subject in connection with cars at this time.

Anxiety about the breakage of staybolts has not been reduced, but increased, during the past few years. Higher pressures do not appear to have increased the present rate of breakage, but it is apparent that the fear of neglect in inspection and the fact that large numbers of broken bolts are frequently found together with the tendency toward still higher pressures causes a great deal of uneasiness. It has brought a number of conservative motive power men to look at relief, even when accompanied by considerable expense, as justifiable. It is to be hoped that it will not be necessary to wait for explosions to bring about a right view of this. Flexible stays which will save side sheets and avoid explosions will be cheap at $1 each, but they may be made for half that amount.

The Navy Department has called for bids for five new battleships and six armored cruisers. The specifications for the battleships call for double-decked turret ships, 435 ft. long on the load water line. The extreme breadth of the water line is to be 76 ft. 10 in. and the trial displacement about 15,000 tons for the sheathed and coppered vessels and 14,600 tons for those unsheathed. They are designed to travel 19 knots an hour and are to have 3,590 tons of armor. The cruisers will be 502 ft. in length, load water line, and 69 ft. 6 in. in width. They will have a speed of 22 knots an hour. The draft will be 26 ft. when loaded and 24 ft. with the ordinary service load. The weight of armor on each cruiser is to be 2,119 tons, with 100 tons of cellulose backing.

The Boston & Albany Railroad having been leased to the New York Central, the mileage of the Albany road will now be added to that of the New York Central, and hereafter a thousand-mile ticket of the New York Central & Hudson River Railroad will be good on the Boston & Albany Railroad. This will prove a great convenience to those who desire to reach points in Massachusetts on or reached via the Boston & Albany, including, of course, Boston. The holder of a New York Central thousand-mile ticket will now have the privilege of riding over lines aggregating more than 6,000 miles of railroad on a ticket costing only two cents per mile, good for the person presenting it and good until used.

Mr. Asa M. Mattice has been appointed Chief Engineer of the Westinghouse Electric and Manufacturing Company, and will enter upon his duties in December. Mr. Mattice was for ten years, up to a year ago, principal assistant to E. D. Leavitt, of Cambridgeport, Mass., and has been actively connected with the design of all the large machinery coming from Mr. Leavitt's office during that time. Mr. Mattice is an engineer graduate of the Naval Academy, of the class of '74, of which class Mr. E. H. Warren, vice-president of the Westinghouse Electric and Manufacturing Company, is also a member. He was assistant to Admiral Melville at the beginning of the new navy. The Westinghouse Company is to be congratulated on the additional strength which he will give to their already strong engineering staff.

COAL CARS OF 80,000 POUNDS CAPACITY.

Chicago, Burlington & Quincy Railroad.

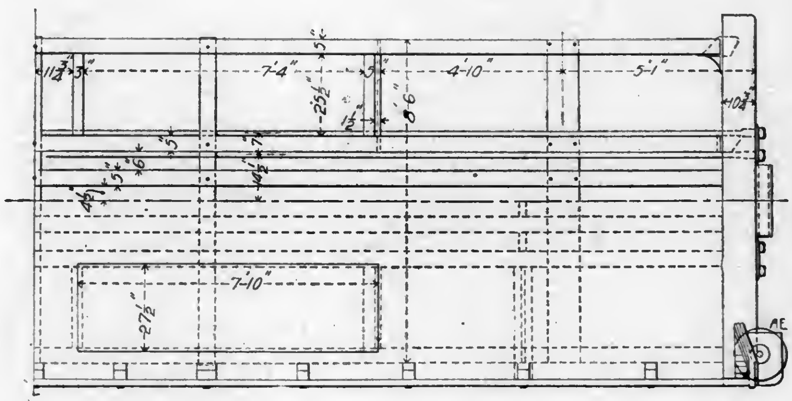
The new coal cars of 40 tons capacity, of which 500 have been built, for the Chicago, Burlington & Quincy Railroad, have several interesting features. The cars are low and are mounted upon low trucks of the diamond frame type, with 5 by 9 in. steel axles. They are all for use in the coal trade, and in order to adapt them to other kinds of service the ends are fitted with doors hinged to fold down inside the cars and against the floors, as shown in Fig. 2. The order was divided in. braces, as shown in Fig. 3. The chief dimensions of the cars are as follows:

80,000-Pound Coal Cars, C., B. & Q. R. R.

Length over end sills	37 ft. 10 in.
Length of box	37 ft. 3½ in.
Width over side sills	9 ft. 9 in.
Width of box, inside	9 ft. 4 in.
Height, top of rail to floor	3 ft. 7½ in.
Height, top of rail to top of box	7 ft. 4¾ in.
Height, top of rail to sills	2 ft. 10½ in.
Depth of box	3 ft. 7 in.
Distance, center to center of trucks	27 ft. 7½ in.
Trucks, wheel base	5 ft. 2 in.
Weight of cars when new	32,000 lbs.

The hopper openings are 7 ft. 10 in. by 2 ft. 3 in., and these

Coal Car, 80,000 Pounds Capacity—C. B. & Q. R. R.
Fig. 1.—Showing Johnson Hopper Doors.



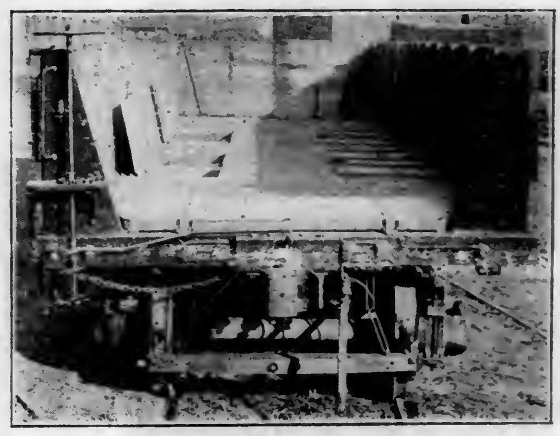


Fig. 2.—Interior View, Showing Open End and Floor Trap Doors.

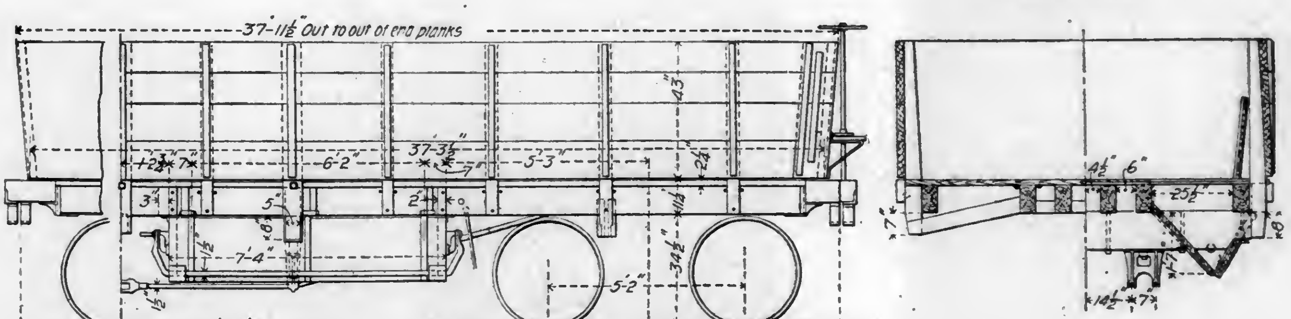


Fig. 3.—Elevation, Plan and Section.

into two lots, of which 300 are plain gondolas to be unloaded by shoveling, while the remainder have Johnson hoppers and hopper doors. Our engravings illustrate the hopper cars, the others being similar to these in general features, but they weigh 29,600 lbs., or 2,400 lbs. less than the hopper cars.

All the cars have six sills, their arrangement on the plain cars being such as to permit of attaching hoppers if desired. The stakes are inside of the siding and five of them on each side of the car extend below the side sills to receive 5 by 2¼ are covered by hinged doors which may be closed at will. When the car is to be unloaded through the hoppers these doors are opened, as in Fig. 2, before loading. The construction of the hoppers is clearly shown in the engravings. Unloading through hoppers is advantageous in the matter of cost, as about half the load may be discharged by gravity, and such cars are becoming so common that shippers are fitting up their trestles to accommodate them.

In Fig. 3 in the upper right-hand corner of the plan view

will be seen a malleable iron sill pocket. This view also shows the arrangement of the truss rods and needle beams. The end construction of the box, or body, is such as to guard against weakness due to cutting away so much material for the end doors. Fig 4 illustrates the 1-in. combination rod and strap which passes through the end sill, along the edge, and over the top of the fixed portion of the end structure, where it is secured to the siding at the corner. The end doors slope away from the center of the car.

The Dayton draft rigging is fitted to 250 of the cars, the remainder having the Miner attachment. The adaptation of the Bettendorf bolsters to this construction is illustrated in Fig. 5. Fig. 6 illustrates the draft gear. The stop bars instead of passing through the sills are notched out and bolted beneath them, lipping up on the outside faces of the sills to prevent them from spreading. The stop bars are secured to the center sills by means of bolts which pass vertically through the sills. The drawing clearly shows the construction and the form of the sill plate. The three chief aims of this gear are (1) to reduce all strains, as far as possible, to crushing, avoiding shearing and bending; (2) to bind the sills together, and (3) to reduce the number of parts.

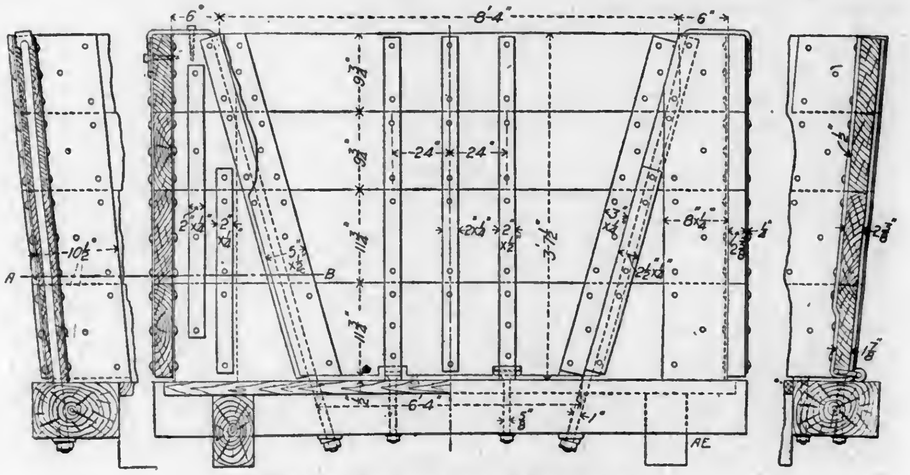


Fig. 4.—Construction of End Doors.

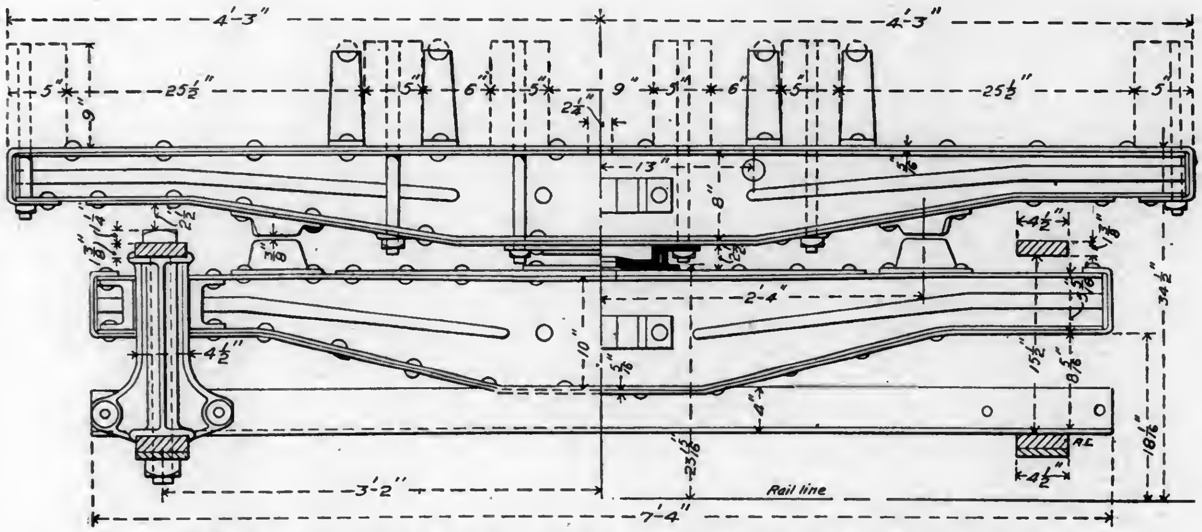
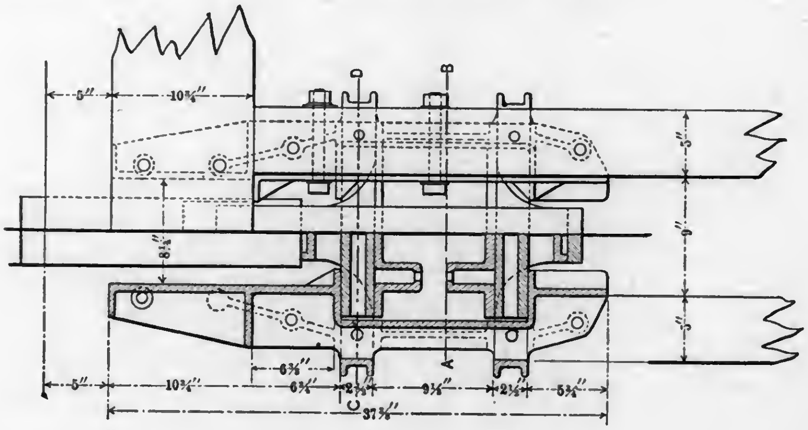


Fig. 5.—Application of Bettendorf Bolsters. 80,000-Pound Cars.—C. B. & O. R. R.



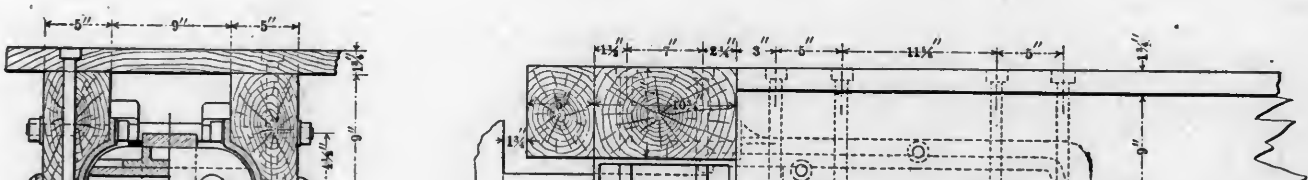


Fig. 6.—Application of Dayton Draft Gear. 80,000-Pound Cars.—C. B. & O. R. R.

The cars are fitted with McCord journal boxes and Westinghouse air brakes, and the Johnson hoppers were applied under patents owned by McCord & Co. The cars were built by the Illinois Car & Equipment Company, Chicago. We are indebted to Mr. F. A. Delano, Superintendent of Motive Power of the road, for the drawings and photographs.

A STUDY IN LOCOMOTIVE FIREBOXES.

For the Benefit of Staybolts.

By F. F. Gaines.

Mechanical Engineer, Lehigh Valley Railroad.

The object of this article is to discuss remedies for the prevention of staybolt failures in the firebox of a locomotive boiler, and to suggest a possibility of discontinuing their use. From the attention devoted to this subject by the technical press, it is seen to be a very live and important topic. The great increase in the average boiler pressure carried during the last five years has naturally intensified an evil already serious and expensive before its advent. To remedy this trouble there has been but one radical departure from the practice in vogue many years back, and little or no work has been done to obtain an understanding of the causes and remedies. The one departure is what is known in this country as the "Vanderbilt Boiler," and while only an experiment here, I believe it has been in use in Germany for a number of years. To have been of value to the railway world it should have been brought out many years ago. As large grate areas are now being generally introduced, it would seem that its limit in this particular will be fatal to its general use.

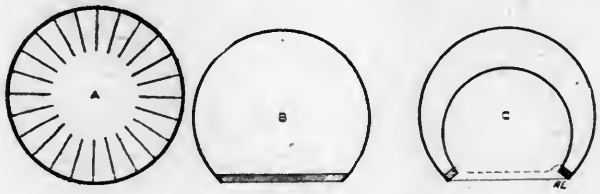


Fig. 1.

Commencing at the fundamental laws of internal pressure on the walls of the containing vessel, we know that if we secure the heads of a cylinder the sides are self-supported (A, Fig. 1) and require no staying. If we should remove a portion of the cylinder and replace the portion removed by a flat surface, sufficiently strong to prevent flexure, and secure this to the walls, as shown in Fig. 1-B, we still have a perfectly self-contained vessel. If we go a step farther and cut out of the flat surface a rectangle and to the inside edges of the band left by the operation secure a portion of another cylinder sufficiently strong to resist collapse under pressure (Fig. 1-C), we have as a result a self-contained vessel of a design applicable as a firebox for a boiler.

To prove that the state of repose of a surface under pressure is a portion of a true circle, the apparatus shown in Fig. 2 was constructed. It consists of two segments of a circle fastened to a base, and a covering of heavy parchment paper, securely fastened, and as nearly air tight as possible. A tube was inserted at each end, one for connecting to air supply and the other for connecting pressure gage. Up to a pressure of 2 lbs. per square inch, at which point a miniature boiler explosion took place, at any point in the length of the parchment, the cross-section was a duplicate of the ends, and a ruler laid from end to end failed to show any distortion whatever. If the state of repose had been a shape different from the segmental ends, with the flexible material and pressure used, we would have had distortion at a section near the center where the influence of the rigid ends was little or nothing, which could not have escaped observation.

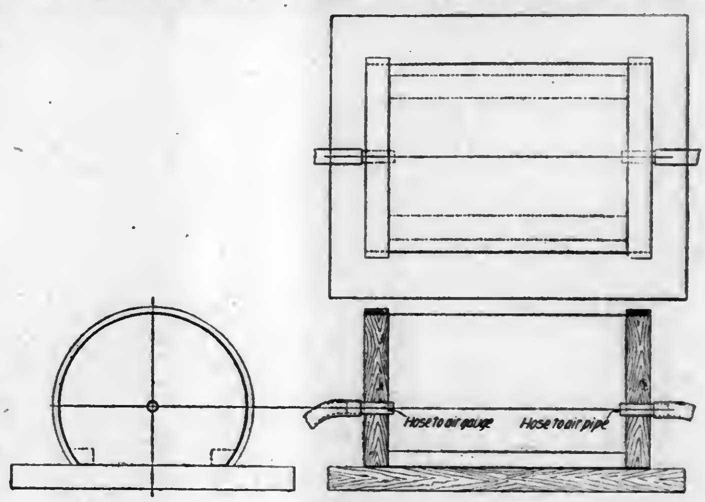


Fig. 2.

Any design which leaves the outer sheet in a state of rest which, no matter how the pressure may vary—from atmospheric to maximum—has no tendency to change its shape, must greatly relieve the distortion and stress of the staybolts. From the same reasoning a design which on the application of pressure tends to assume a different shape must throw abnormal loads on the staybolts, such loads being much greater than the amount due to steam pressure alone, as the bolts have not only to hold against the steam, but to resist a certain extent the tendency of the outer sheet to assume the form of a segment of circle. Theory would indicate that the outer sheet, having a load in excess of the inner, would have a tendency, due to this excess load, to assume a segmental form, the plane of the mud ring forming the chord.

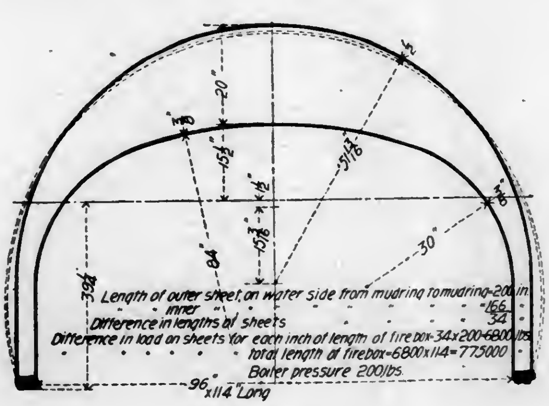


Fig. 3.

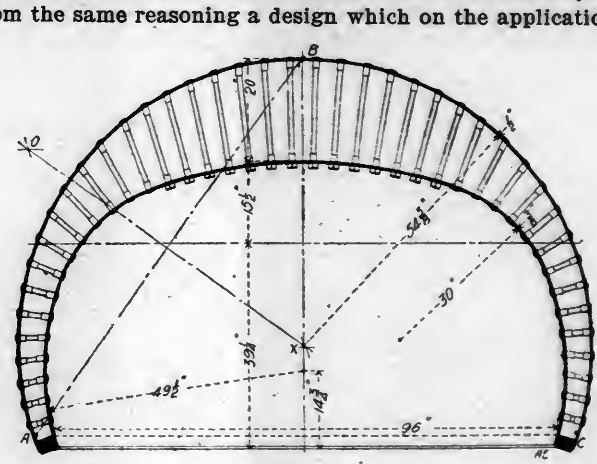


Fig. 4.

Figs. 3, 5, 8 and 9 are sections of boilers which have been

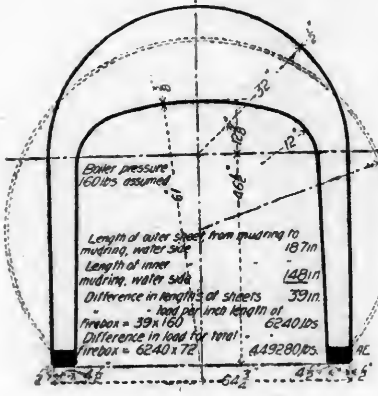


Fig. 5.

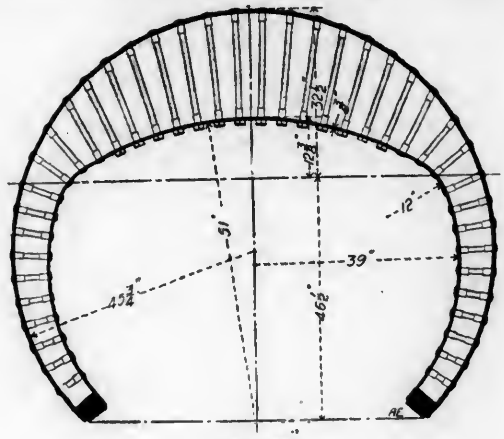


Fig. 6.

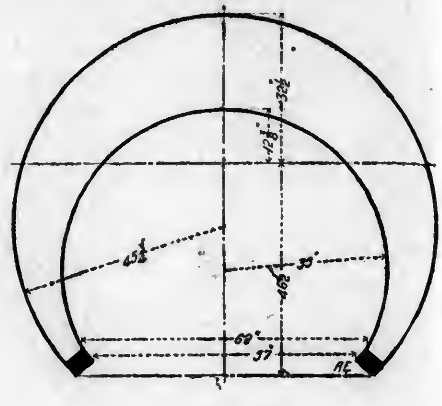


Fig. 7.

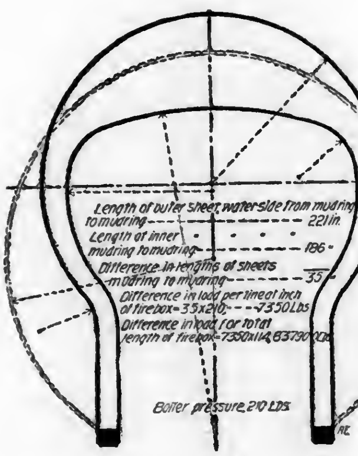


Fig. 8.

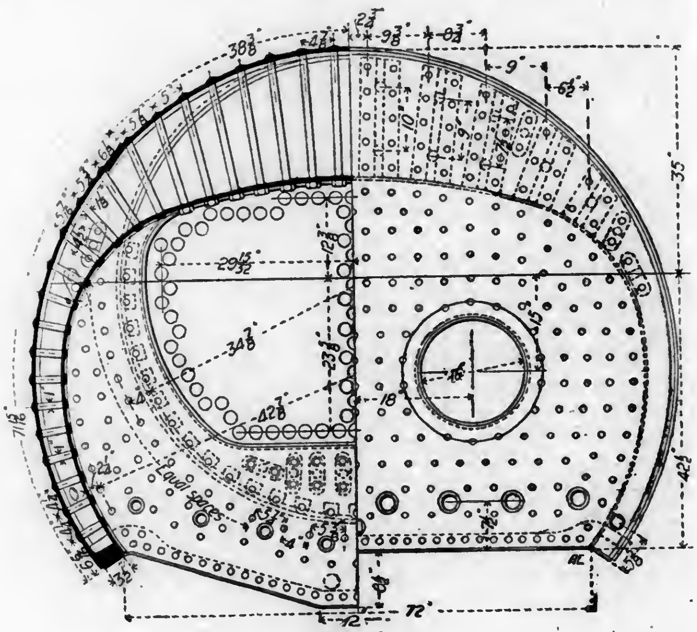


Fig. 11.

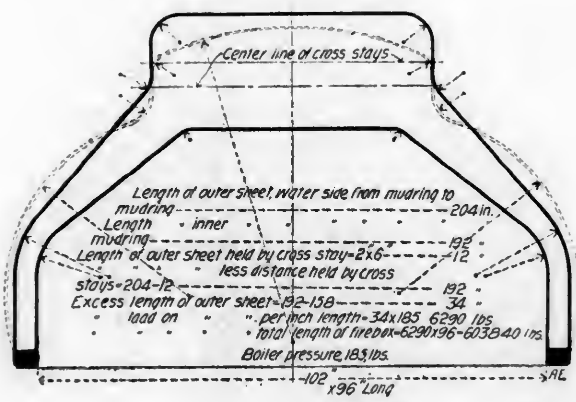


Fig. 9.

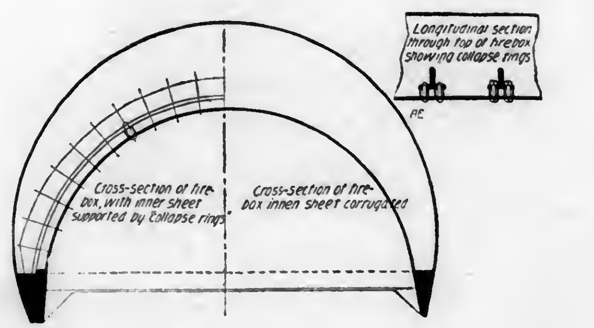


Fig. 10.

A Study in Locomotive Fireboxes. By F. F. Gaines, Mechanical Engineer Lehigh Valley Railroad.

published in the railway papers within the present year, and the dimensions shown are as nearly as possible those of actual boilers. The full lines in Fig. 3 show the section of a wide firebox; the dotted lines, the same length of sheet between the mud-ring joints, but a segment of a circle. The length of the outer sheet on the water side, from mud ring to mud ring, is 200 ins. The length of the inner sheet from the same points, and on the water side, is 166 ins. This gives the outer sheet an excess length of 34 ins. With 200 lbs. pressure and a firebox length of 114 ins., the excess load on the outer sheet, tending to force it to assume the shape shown by the dotted lines, is 775,000 lbs. This design very nearly approaches the theoretical, as shown in Fig. 4, which is interchangeable with that shown in Fig. 3, and has the same leading dimensions. The diameter of the circle of the outer sheet is determined by taking the three points, A, B and C, from Fig. 3, and passing a circle through them. Fig. 5 shows a section of firebox of a width I shall call "The Compromise." The full and dotted lines have the same meaning as in the previous case. The excess load on the outer sheet is less, 449,000 lbs., but the change of shape necessary to attain a state of repose is much greater. Fig. 6 is a section with

the outer shell segmental, and Fig. 7 a section with both inner and outer shells segmental; both Figs. 6 and 7 are interchangeable with the boiler for Fig. 5.

Fig. 8 shows the section of a narrow box. Here the excess load of 837,900 lbs. on the outer sheet has a tendency to cause considerable distortion. The ideal section for this boiler would be similar to Figs. 6 and 7.

Fig. 9 shows a section of a firebox that is a combination of the Belpaire and wide box. From the nature of the cross-staying, it is difficult to say just what the tendency to distortion amounts to, and what the shape of repose; it is probable, however, that it is somewhere near the dotted lines shown. It would depend largely on how far the influence of the cross-stays extends. From the standpoint of this article, its section leaves much to be desired.

If these excess loads on the outer sheets were equally divided between all the staybolts, it would be a matter of no great moment, but it seems probable that this excess is confined to those staybolts that are located at the points where the theoretical and actual lines diverge most widely—provided the divergence causes tension. Taking the firebox sections illustrated, we might expect to find the largest number of broken staybolts at those places of greatest divergence along the sides. On the crown, where the theoretical lines drop below the actual, we might expect to find those stays nearest the ends in compression, where the flue and door sheets support and hold the inner crown sheet rigidly. Experiments that have been made at different times have proved the latter expectation. The reasons that have been given for this state of affairs has generally been charged to the mythical force called expansion. I have never been satisfied with this explanation, and it was the cause of my investigating the matter from all sides. It led up, eventually, to the evolution of the theory that to remedy the known distortion and rupture of staybolts, the outer sheet at least should be in a state of repose. With the outer sheet in this condition, the only forces acting on it are the steam pressure forcing it out and the steam pressure on the inner sheet through the staybolts pulling it in. As the former must always exceed the latter, and as there is no tendency to alter its shape on account of the outward pressure, it is readily seen that there is nothing tending to a change of section under any possible variation of allowable pressure. Under these circumstances, the staybolts have only to carry the normal load on the inner sheet, which load is uniformly distributed among them all. Figs. 11 and 12 show two views of a boiler designed in accordance with this theory. As it was designed for an actual engine, where the limiting wheel weights would not allow any further increase in the weight of the boiler, the inner sheet is not segmental. Were it possible to allow the additional weight due to increasing the water space, the inner sheet could also have been made segmental. This would have resulted in lessening the load on the staybolts, by the amount of strength possessed by the inner sheet against collapse.

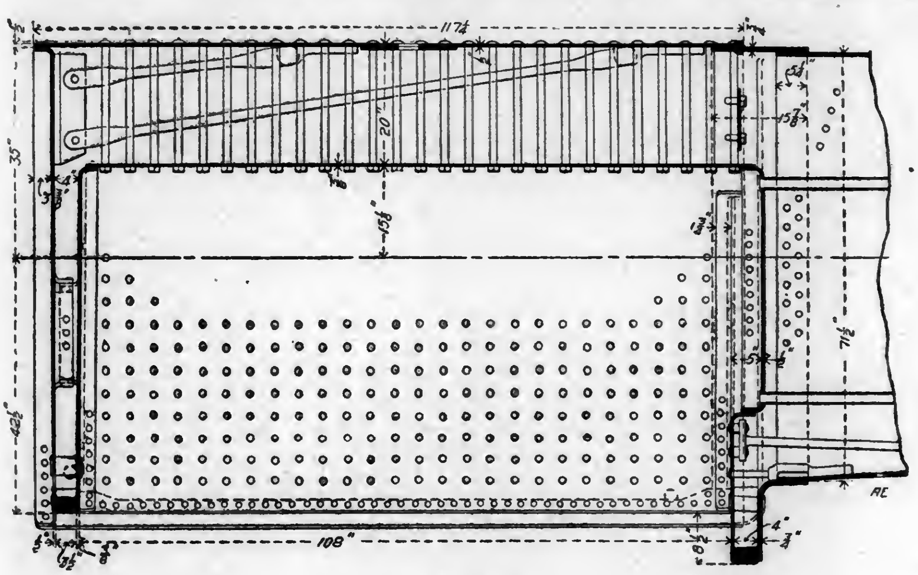


Fig 12.

The segmental firebox, especially where both inner and outer sheets are segmental, has many advantages to recommend it, besides the probable diminution of staybolt failures. With the regular firebox, especially the wide ones, it requires frequent firing to keep coal on the grates at the sides, while the segmental form would remedy this fault. The contour presents a surface that is accessible to the heat at all points, and one which the flame will readily follow from the fire to the crown. The enclosed space is a maximum, thus providing a greater possibility for the thorough mixing of air and gases for production of perfect combustion.

I now wish to take up a phase of the subject of which I have no definite knowledge, but one which I think it is possible to develop, as I see no overwhelming obstacles. Fig. 10 shows a sketch of two firebox sections, neither of which requires staybolts. The outer and inner sheets are segments of circles. On one side a plain inner sheet is shown supported by collapse rings. The tee-shaped collapse ring is shown as being the simplest, but many other forms can be found in any English text-book on boiler design. The other side has the inner sheet of corrugated material, which is self-sustaining against collapse. With a sufficiently strong joint at the mud ring, either style is just as practicable as where the shell is a true cylinder. This design is equally applicable to all widths of grates, but will give a heavier firebox than present designs on account of the greater water space. These spaces on the other hand, would give good circulation, and should make a free steaming boiler. The design of the mud ring calls for special treatment, and the two sides would have to be well tied to prevent a "Bourdon gage" action. Owing to the probable irregularity of section and corners, steel castings would probably prove the most economical for the purpose. To prove the value of such a design, it would be necessary to build an experimental boiler. It is to be hoped that some road, imbued with the spirit of progress, will experiment along these lines in the near future.

"Why has the swing beam truck been so largely abandoned for freight service?" was the subject of a topical discussion at a recent meeting of the New York Railroad Club. The general opinion seemed to be that it was merely a matter of cost of construction and maintenance, the difference between the rigid and swing trucks in these respects being about 10 per cent. in favor of the rigid truck. A good point was made by Mr. L. R. Pomeroy, of the Schenectady Locomotive Works, concerning the possibilities of "saving too expensively" in the matter of trucks. He said: "Some years ago, when it was quite prevalent to use the pressed steel type of truck with pedestal boxes under tenders we found that they were failing very rapidly and continued to do so until the truck was redesigned with a floating bolster which practically made it a swing-motion truck, and now that truck is being very largely used for tenders and is considered to be very successful. That might be an illustration that we are coming back to the swing-motion truck in the most trying service we can possibly get."

PROMISING IMPROVEMENTS IN DRAFT GEARS.

The draft-gear situation is encouraging. With the amount of thought now devoted to it, draft gear is bound to improve, and the awakening of interest will bring about a radical change which everyone knows is greatly needed. More money will be put into draft gear in order to save greater expenses in repairs which will be necessary on account of the weaknesses of the old types of attachments.

Some radical differences of opinion may naturally be expected in such a matter. Mr. George Westinghouse, in a recent communication to the "Railroad Gazette," represents one view when he says: "By their united action a form of coupler and draft gear adequate to meet all possible contingencies can and should be selected and decided upon as a standard for all new cars, and which will also be suitable to replace the hundreds of imperfect and weak kinds now in service."

Mr. R. P. C. Sanderson thinks otherwise. He may always be depended upon for an opinion, carefully formed, and vigorously supported, from observation, but with a liberal disregard of the weight of the opinions of the majority, merely because they are those of a majority. In his paper before the Western Railway Club last month is the following paragraph:

"Having reached the conclusion that in modern train service the train shocks were of such momentum as to be quite beyond the power of any reasonable springs to absorb (and assuming we had spring capacity to do this, the recoil would itself cause break-in-twos), the malleable-iron dead block becomes a necessity to protect the couplers. There is trouble enough with the M. C. B. coupler to-day without making it act as a collision buffer. It is too expensive to be used to take up shocks that are beyond the capacity of the draft springs."

It seems reasonable to suppose that many coupler failures are due to inadequate yielding resistance, and that if sufficient soft resistance is provided the couplers will not suffer. May it not be a step backward to rely upon buffer blocks which will carry some of the shock to the framing direct? On the other hand, the break-in-twos are caused by pulling or jerk stresses, and the dead blocks will not avail in the least in that case.

At the beginning of these comments it was said that the draft gear situation is encouraging. This is confirmed by results of tests on a number of new draft gears recorded by Mr. Sanderson in his paper. One of the nine draft gears was not damaged at all under a 1,640-lb. drop, with three blows at 5 ft., 10 blows at 10 ft. (with the springs in place), then 3 blows at 5 ft. (with blocks in place of the springs) and 7 more blows at 10 ft. (with the blocks in place of the springs). At this stage in the test the pocket bolts began to shear, but after they were replaced the punishment was continued by 3 more 10-ft. blows (with the blocks), and 13 more beginning at 10 ft. and increasing by 1 ft. each time up to 20 ft., the test ending with 3 20-ft. blows. Beyond the shearing of the bolts a second time, and the bending of one of the stop bars, there seemed to be no damage to the gear. This was a twin-spring gear having malleable draft beams, with the cheek plates incorporated into the draft beams. Mr. Sanderson's tests, while not conclusive, furnish information which is valuable in the selection of gears to those who know the names of the ones tested, and they certainly indicate considerable improvement in the matter of strength. But the drop test needs to be supplemented with something like 40 or 60-car train tests, in order to throw light on the question of break-in-twos. Strength or spring capacity does not cover all the desirable qualities, and in this all will agree with Mr. Sanderson.

A clean gift of one million dollars from Andrew Carnegie, and a promise of more if needed, will establish a technical school in Pittsburgh. It will be founded on the idea of offering technical instruction to self-supporting students and place the privileges of education within the reach of artisans and mechanics. It will fill a great need, but considerable difficulty in finding the right sort of instructors may be expected.

THE CONFUSION OF TYPES.

A Logical Locomotive Classification Needed.

The past year has brought out a large number of different locomotive designs, and probably a greater variety than have ever appeared in a similar period, and there are more to come. It is desirable that each class should have a name representing its characteristics in some logical way which will correspond with the usual type designations which generally refer to the wheel arrangement. The number of "types" is increasing, and the nomenclature is tending toward confusion. The "ten-wheel" type is now likely to be confused with the "Atlantic," the "Northwestern," the "Chautauqua," the "Fan Tail," the "Consolidation" and others yet to come, which have ten wheels, unless some simple scheme of classification is devised. We also have the "Decapod" and the "Mastodon" and the "Twelve-Wheel" types. There are too many names, and the tendency is to give a type designation to a new design the only peculiarity of which is the outside or inside journals of the trailing wheels. Mr. F. M. Whyte, Mechanical Engineer of the New York Central, comes to the rescue with a suggestion which seems to meet the requirements in every way, and it is presented with a view of obtaining criticisms and suggestions. The plan is to designate the number of wheels in three groups; those in front of the drivers, the drivers themselves, and those in the rear of the drivers. An 8-wheel engine is a 4-4-0 (or a 4-4), a 10-wheel is 4-6-0 (or 4-6), an Atlantic type 4-4-2, a consolidation 2-8-0 (or a 2-8), the Prairie type 2-6-2. Any possible wheel arrangement may be covered by this simple classification. If such a classification is adopted the present confusion of type names may be overcome. If any of our readers can suggest a better plan we shall be glad to have it, with their criticisms on this one.

Mr. J. Shirley Eaton, Statistician of the Lehigh Valley Railroad Company, has been engaged to give a course of lectures during January, 1901, before the students of the Tuck School of Dartmouth College, upon the "Theory and Practice of Railroad Statistics." Mr. Eaton is well qualified by his many years of special experience in railroad accounting for the novel course of lectures which he is to undertake. The course will include a general discussion of railroad revenue and expenditure, followed by a detailed study of freight and ticket accounts and statistics, operating statistics, store requisitions, car accounting, and the general books, such as balance sheet, various journals, side ledgers, and accounts and reports of the Superintendent's office, and of the Master Mechanic and the Division Engineer.

The Car Foremen's Association of Chicago, an organization of men who have to do directly with the M. C. B. interchange rules, and who meet for discussion of the rules, deserves encouragement as it is doing a good work which should be a material help to the M. C. B. Association. At the November meeting, Mr. J. C. Grieb, of the Chicago, Milwaukee & St. Paul Railroad, presented an analysis of the 603 cases which have been decided by the Arbitration Committee, and made some excellent suggestions looking to a reduction of the number of uses submitted. The first was rendered in 1888, and their number has averaged about 50 per year. The Car Foremen's Association furnished means for coming to an understanding among its members, and one result to be expected from it is a reduction of the number of disputed cases through better personal understanding at the interchange points. Mr. Grieb suggests the importance of a complete index of the decisions as a guide to the settlement of cases by reference to previous decisions. He also recommends less brevity and more explicit language in the decisions themselves in order that the reasons of the committee forming the basis for a decision may be better understood. Citing the rules used as authority for a decision would meet Mr. Grieb's recommendation. These matters should be brought to the attention of the M. C. B. Association next year.

PASSENGER LOCOMOTIVE WITH WIDE FIREBOX.

Burlington, Cedar Rapids & Northern Railroad.

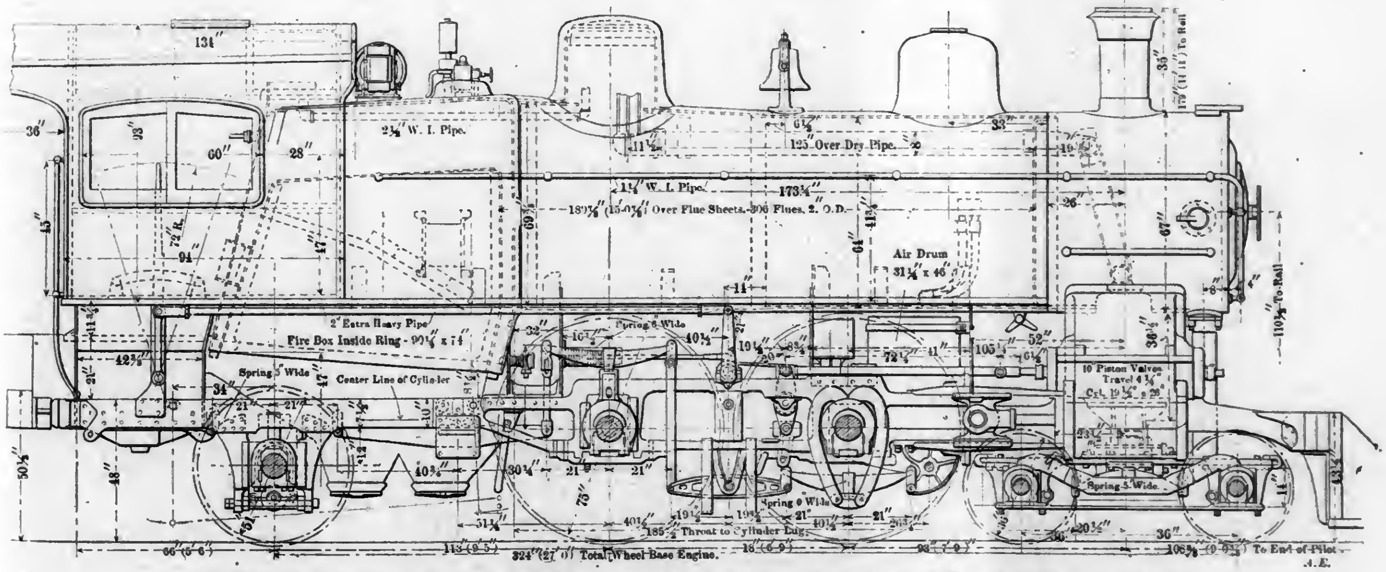
Brooks Locomotive Works, "Chautauqua" Type.

Three interesting passenger locomotives with wide fireboxes have just been delivered by the Brooks Locomotive Works to the Burlington, Cedar Rapids & Northern. They are called "Chautauqua" type, but it is to be hoped that each new design is not to be christened with a name, or the confusion will izer at the rear of the main driving wheels gives a good arrangement for the equalization of the weight. Three points of support are provided for the rear equalizers whereby greater or less weight may be placed upon the drivers as may be desired. This is accomplished by changing the position of pins upon which these equalizers rest. Cast steel is used for the main equalizers and the driving springs are 6 ins. wide, the trailer springs being 5 ins. wide. A good arrangement of the front frames is secured by the location of the piston valves and the stresses must necessarily be quite direct with the use of the single bar in front, which is straight and deep in section.

PASSENGER LOCOMOTIVE, WITH WIDE FIREBOX—"CHAUTAUQUA" TYPE.

BURLINGTON, CEDAR RAPIDS & NORTHERN R. R. BROOKS LOCOMOTIVE WORKS, *Builders*.

Weights: Total of engine........ 158,600 lbs.; on drivers............88,000 lbs.; total of engine and tender .... 265,600 lbs.
Wheel base: Driving.......6 ft 9 in.; total of engine...............27 ft.; total of engine and tender ....52 ft. 11¼ in.
Cylinders. 19½ x 26 in. Wheels: Driving........75 in; truck...........36 in; tender............36 in.
Boiler: Diameter....... 64 in; boiler pressure.......... 210 lbs.
Firebox: Length. ......90¼ in.; width ....74 in.; depth, front .... 68 in.; back............57 in.
Grate area...... 45.32 sq. ft. Tubes: 306; 2 in., 15 ft. 1 in long.
Heating surface. Tubes ..... 2,396 sq. ft.; firebox. ..... 155.8 sq. ft.; total ....2,551.8 sq. ft.
Tender: Eight-wheel; water capacity............5,000 gals.; coal capacity.........10 tons.



Passenger Locomotive, with Wide Firebox—Burlington, Cedar Rapids & Northern Railroad.

soon be complete. The wheel arrangement is that of the old Atlantic type. The engine combines the wide firebox, Belpaire boiler, piston valves and a radial trailing truck.

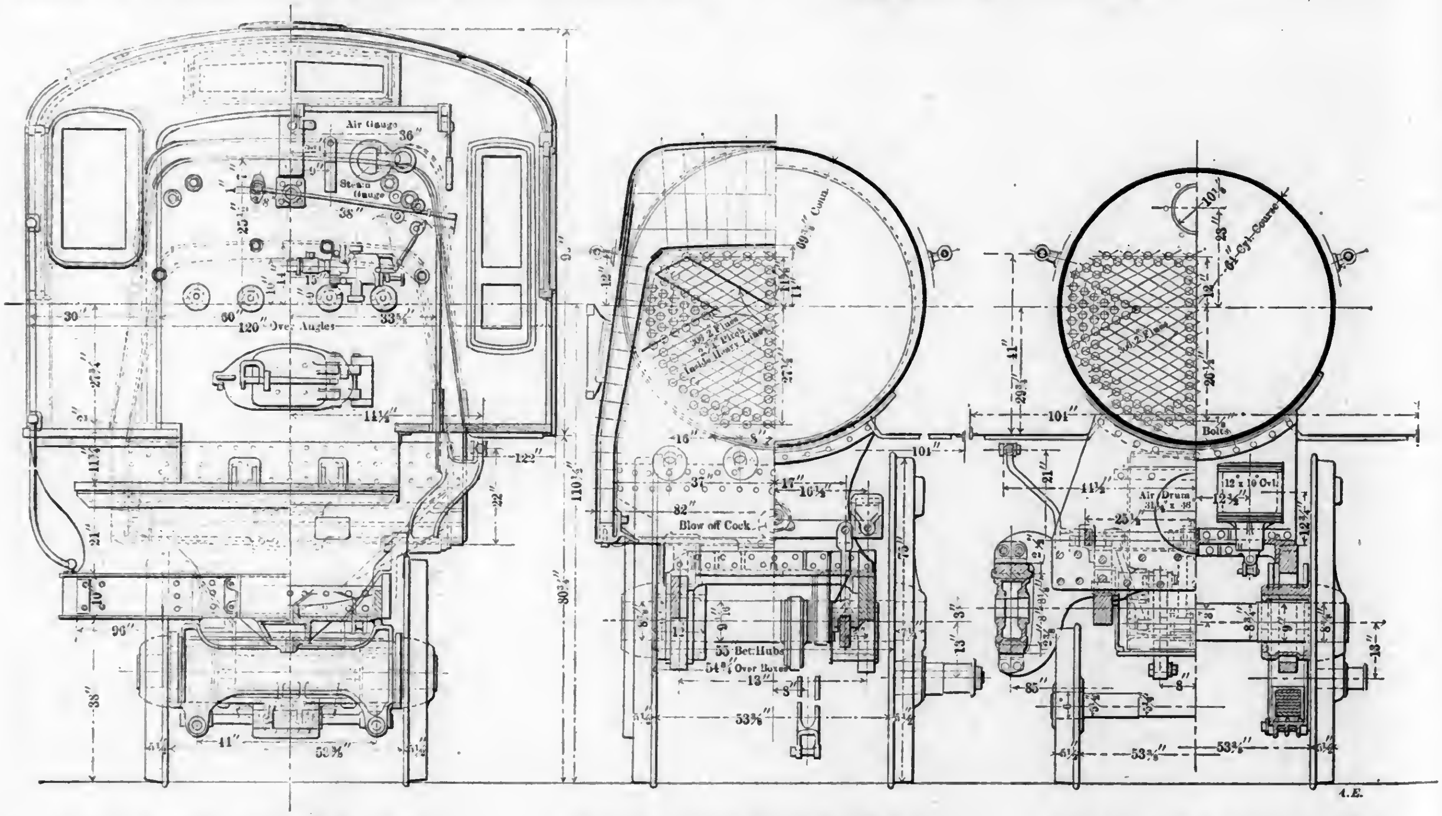
The firebox is wide and deep, with a brick arch supported on water tubes. With 75-in. drivers, the center of the boiler is 9 ft. 2½ ins. above the rail. A radial truck is a novelty which has been skilfully applied, and it gives an excellent arrangement of the back end of the engine and leaves plenty of room for the ash pan. The truck has a spring centering device and is as simple as one could wish. It permits of carrying the frames straight to the rear ends, and a cross equal-

With 75-in. wheels, 19½ by 26-in. cylinders and 210 lbs. boiler pressure, the tractive power is 22,409 lbs. The tubes are 15 ft. long and the boiler 64 ins. in diameter. Among the details we note that the piston valves are 10 ins. in diameter with central admission. The valve chamber is extended at the ends in order to give free exhaust passages without increasing the steam clearances by increasing the length of the steam admission ports. Marine links are used, giving a valve travel of 4¼ ins. The boiler is supported by plates secured to the front and rear water legs of the firebox, the front plate being fastened to a cast-steel lateral brace extending across

the engine between the frames. The cab deck is supported on angles secured to the cab plate and the cab bracket, which is also a plate.

For a wide firebox engine the cab is remarkably roomy, to which the sloping back head of the boiler contributes. It is of steel and 10 ft. wide. The Bell front end is used, with a straight cinder spout for which there is just room enough in front of the saddle. The reach rod is of 2-in. extra heavy pipe. With this arrangement of valves both rocker arms are inside the frames. The sectional drawings show this clearly. Attention is attracted to the location of the driver brake cylinders at the front drivers, with the brake shoes at the rear of the driving wheels, which is becoming quite general in passenger locomotives. In this case the main reservoir is 31¼ by 46 ins. and is located with its axis vertical, under the boiler and in front of the forward driving axle. We note the large journals throughout and enlarged wheel fits of the main crank pins. Another interesting detail is the grate bearer, which provides for a packed joint against the inside firebox sheet to prevent the passage of air at the edges of the grates. This should become general practice because it pre-

General Dimensions.	"Chautauqua."	"Northwestern."
Wheel base, total of engine	27 ft. 0 in.	23 ft. 9 in.
" driving	6 ft. 9 in.	7 ft. 0 in.
" rear driver to trailer	9 ft. 5 in.	9 ft. 0 in.
" total, engine and tender	52 ft. 11¼ in.	....
Length over all, engine	38 ft. 11½ in.	....
" " total, engine and tender	62 ft. 4½ in.	....
Height, center of boiler above rails	9 ft. 2½ in.	9 ft. 1½ in.
Height of stack above rails	14 ft. 11 in.	15 ft. 1⅛ in.
Heating surface, firebox	155.8 sq. ft.	198.97 sq. ft.
" tubes	2,396 sq. ft	2,816.91 sq. ft.
" total	2,551.8 sq. ft.	3,015.88 sq. ft.
Grate area	45.32 sq. 6t.	46.27 sq. ft.
Wheels and Journals.		
Drivers, number	4	4
" diameter	75 in.	80 in.
" material of center	Cast steel.	Cast steel.
Truck wheels, diameter	36 in.	36 in.
Trailing wheels, diameter	51 in.	48 in.
Journals, driving axle	9 in. x 12 in.	9 in. x 12 in.
" truck "	5½ in. x 12 in.	6 in. x 10 in.
" trailing "	8 in. x 14 in.	7½ in. x 12 in.
Main crank pin, size	6½ in. x 6½ in.	....
" coupling pin, size	7 in. x 4½ in.	....
" diameter, wheel fit	7⅜ in.	....
Trailing axle, type	Radial.	Rigid.
Cylinders.		
Cylinder, diameter	19½ in.	20 in.
Piston, stroke	26 in.	26 in.
" rod, diameter	3⅝ in.	....
Main rod, length center to center	124½ in.	....
Steam ports, length	22 in.	....
" width	1⅞ in.	....



Section and End Elevation at the Cab. Section Through Boiler and Firebox. Section Through Running Gear.

"Chautauqua" Type Locomotive—Burlington, Cedar Rapids & Northern Railway.

vents the destructive blowpipe action against the sheets due to the inrushing of air at these points. The tender has a coal deck over the water space, the line of the deck sheet being indicated by the rivets seen in the photograph. The tender has steps at the rear end.

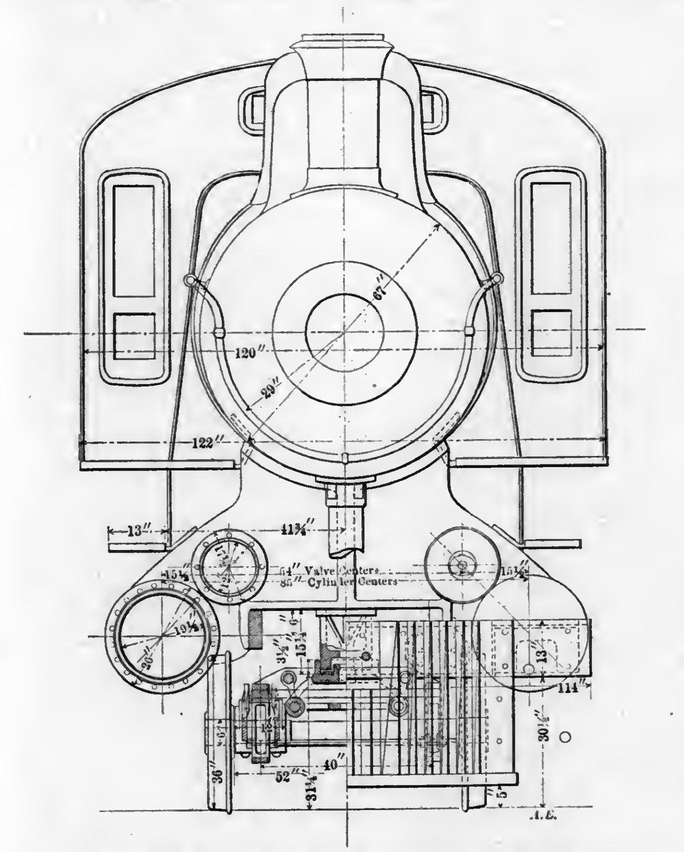
To facilitate comparison with the new Chicago & Northwestern engine built by the Schenectady Locomotive Works (see American Engineer, August, 1900, page 237), the principal dimensions are arranged in parallel columns in the following table:

Comparisons of "Chautauqua" and "Northwestern" Type Locomotives.

Builder	Brooks.	Schenectady.
Type	"Chautauqua."	"Northwestern."
Operating road	B., C. R. & N. Ry.	C. & N. W. Ry.
Gauge	4 ft. 8½ in.	4 ft. 8½ in.
Kind of fuel to be used	Bituminous coal.	Bituminous coal.
Weight on drivers	88,000 lbs.	90,000 lbs.
" truck	35,600 lbs.	35,000 lbs.
" trailer	35,000 lbs.	37,000 lbs.
Weight, total	158,600 lbs.	162,000 lbs.
" tender, loaded	107,000 lbs.	....

Exhaust ports, least area	75 sq. in.	....
Bridge, width	2⅝ in.	....
Valves.		
Valves, kind of	10 in. piston.	11 in. piston.
" greatest travel	4¼ in.	....
" steam lap inside	1 in.	....
" exhaust lap or clearance (outside)	line and line.	....
Valve Motion, Forward Gear.		
Lead, full gear	3/32 in.	....
" 6 in. cut-off	¼ in.	....
Port opening 6 in. cut-off	5/16 in.	....
Pre-admission 6 in. cut-off	13/16 in.	....
Exhaust opens "	17½ in.	....
Cut-off, full gear	21½ in.	....
Valve Motion, Backward Gear.		
Lead, full gear	− 3/32 in.	....
" 8 in. cut-off	+ 3/16 in.	....
Port opening, 8 in. cut-off	5/16 in.	....
Exhaust opens "	18¾ in.	....
Cut-off, full gear	21½ in.	....
Boiler.		
Boiler, type of	Player-Belpaire wagon top.	Radial stayed straight top.
Boiler, working steam pressure	210 lbs.	200 lbs.
" material in shell	Steel.	....
" thickness of material in shell	⅝, 11/16, 9/16, and ½ in.	½ in.

	"Chautauqua."	"Northwestern."
Boiler, thickness of tube sheet	¾ in.	....
" diameter of shell, front	64 in.	68 in.
" " " at throat	69⅜ in.	69¾ in.
" " at back head	64 in.	69¾ in.
Seams, kind of horizontal	Sextuple butt and quintuple lap.	....
Seams, kind of circumferential	Double and triple lap.	Double lap.
Crown sheet stayed with	Direct stays.	Radial stays.
Dome, diameter	30 in.	30 in.
Firebox.		
Firebox, type	Long sloping over trailer.	Long sloping over trailer.
Firebox, length	90¼ in.	103 in.
" width	74 in.	66 in.
" depth, front	68 in.	76¼ in.
" " back	57 in.	67 in.
" material	Steel.	....
" thickness of sheets	Crown, ⅜ in.; tube, ⅝ in.; sides and back, ⅜ in.	Crown, ⅜ in.; tube, ½ in.; sides and back, ⅜ in.
" brick arch	On 4 water tubes.	On 4 water tubes.
" mud ring width, back	3½ in.	3½ in.
" " " sides	3½ in.	3½ in.
" " " front	4 in.	4 in.
" water space at top, back	7 in.	....
" " " sides	5 in.	....
" " " front	4 in.	....
Grates, kind of	Rocking.	....
Tubes, number of	306.	338.
" pitch	2¾ in.	2 13/32 in.
" outside diameter	2 in.	2 in.
" length over tube sheets	15 ft. ⅞ in.	16 ft. 0 in.
Smokebox.		
Smokebox, diameter outside	67 in.	71¼ in.
" length from flue sheet	58½ in.	71 7/16 in.
Other Parts.		
Exhaust nozzle	Single.	....
" area	17.7 sq. in.	....



Front Elevation and Section through Cylinders.

Netting, wire or plate	Wire.	....
" size of mesh or perforation	2½ x 2½. in.	....
Stack, straight or taper	Taper.	Taper.
" least diameter	15⅝ in.	....
" greatest "	17⅛ in.	....
" height above smokebox	35 in.	36 in.
Tender.		
Type	8-whl. steel frame.	8-whl. steel frame,
Tank, type	Slope top.	....
" capacity, for water	5,000 gals.	5,200 gals.
" " " coal	10 tons.	....
" material	Steel.	....
" Thickness of sheets	¼ in.	....
Type of under frame	10 in. steel chan'l.	....
" truck	B. L. W. 100,000 lbs.	....
" springs	Double elliptic.	....
Diameter of wheel	36 in.	....
" and length of journal	5 in. x 9 in.	5 in. x 9 in.
Distance between centers of journals	76 in.	....
Diameter of wheel fit on axle	6⅜ in.	....
" center of axle	5⅜ in.	....

Length of tender over bumper beams	21 ft. 1½ in.	....
" tank	19 ft. 6 in.	....
Width of tank	10 ft. 0 in.	....
Height of tank, including collar	5 ft. 0 in.	....

In a paper upon compressed air motors read before the New York State Street Railway Association, Mr. H. D. Cooke recently stated that the advantage in reheating the air for the motors to an initial temperature of 300 deg. made the difference between a possible mileage of 8 and 15 miles which could be run with a storage capacity of 35 cu. ft., the distance traveled with cold air. Cars operated for six months in Chicago required an average of 409 cu. ft. of free air per mile, which was compressed to 2,000 lbs. per square inch for storage. In brief, the advantages of compressed air for the operation of street railways may be summed up as follows, viz.:

1. A system of independent motors, which, after receiving their charges, does not rely upon the power plant, and which will always finish their run, should anything happen to the power plant; which also does not need any special out-door construction, either underground or overhead, with the attendant cost of maintenance.
2. Slow-moving machinery, both in the power house and on the car, which is easily maintained.
3. Opportunity for charging cars, and storage in power house, during light hours, for use during rush hours.
4. Spring-supported motors and load, doing away with excessive jarring and pounding on the track, and thus greatly prolonging the life of the roadbed, the life of the motors, and contributing to the easy riding of the cars.
5. Low first cost of plant, low cost of maintenance and opportunity for making repairs and adjustment without stopping operation of cars.
6. Freedom from liability of delay in transit from snow, ice or sleet.

Steel rail production has had a marvelous history during the thirty-two years since it began. In 1868, says the Railway Age, rails sold at $174 a ton, but even at this price a few railway companies had decided that it was economy to begin to use them instead of iron. Ten years later, in 1878, the price had dropped to $41.50, and about one-quarter of the railway mileage of the country was of steel rails. During the next ten years the price first doubled, reaching $85 in 1880, and then declined to $31.50 in 1888, by which time there were 130,388 miles of steel tracks, against 52,979 miles of iron. At the end of another decade, in 1898, the price had fallen to $18, and there were 220,800 miles of steel tracks, only about 24,000 miles of iron remaining. The following year, 1899, saw nearly 9,000 miles of steel added, although in the course of the year, the price had almost doubled. To-day the mileage of steel is about 230,000, as compared with 20,000 miles of iron—that is, 92 per cent. steel and 8 per cent. iron—and the battered relics of the iron age that still linger in scattered sidings and spur tracks will soon disappear. Although the price, $26, fixed by the mills for the coming year, is an advance of $8 over the price at the commencement of 1899, it is less than the average quotation for that year. But it is a higher figure than the large purchasers expected to pay and if maintained may somewhat diminish the amount of new construction and renewals which had been planned on the expectation of a lower price. Still, compared with $174 a ton, even $26 seems cheap.

A reduction in the size of auxiliary reservoirs for 16-in. air-brake cylinders is recommended by the Westinghouse Air Brake Company. Heretofore they have recommended a special auxiliary reservoir 18½ by 41 ins. in size for use in connection with 16-in. cylinders upon the assumption that the brake arrangement for locomotives requiring cylinders of this size would not admit of a piston travel shorter than 6 ins. A further study of the situation, however, has resulted in a series of brake designs in which the minimum piston travel may be advantageously reduced to 4 ins., and on this basis careful experiments have shown that the most satisfactory results can be obtained by reducing the size of the auxiliary from 18½ ins. by 41 ins. to 16 ins. by 42 ins. The latter size has, therefore, been adopted as standard for use in connection with 16-in. cylinders of all kinds.

PULVERIZED FUEL.

About ten years ago D. K. Clark referred to the use of powdered coal as "unique and interesting." It is now much more than that and is worthy of the most careful attention of engineers in view of its apparently very promising possibilities. The idea dates back to 1831, when Henschel carried out experiments at Cassel, Prussia, in connection with brick kilns and heating furnaces. While progress has been made continually it was not until recently that commercial success has been attained in practical operations, but its present employment in connection with the manufacture of cement in this country and also in firing boilers both here and abroad entitle it to a consideration which it has not yet attracted.

The burning of fuel in finely divided form permits of turning the fuel into gas and obtaining a perfect and prompt intermixture of the gas and air. This constitutes perfect combustion, which is necessarily smokeless, and there is good reason to believe that the results are almost as good with poor as with good grades of coal, but, of course, the better the coal

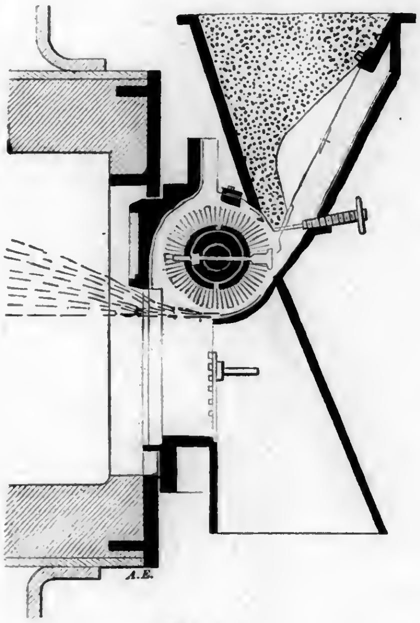


Fig. 1.

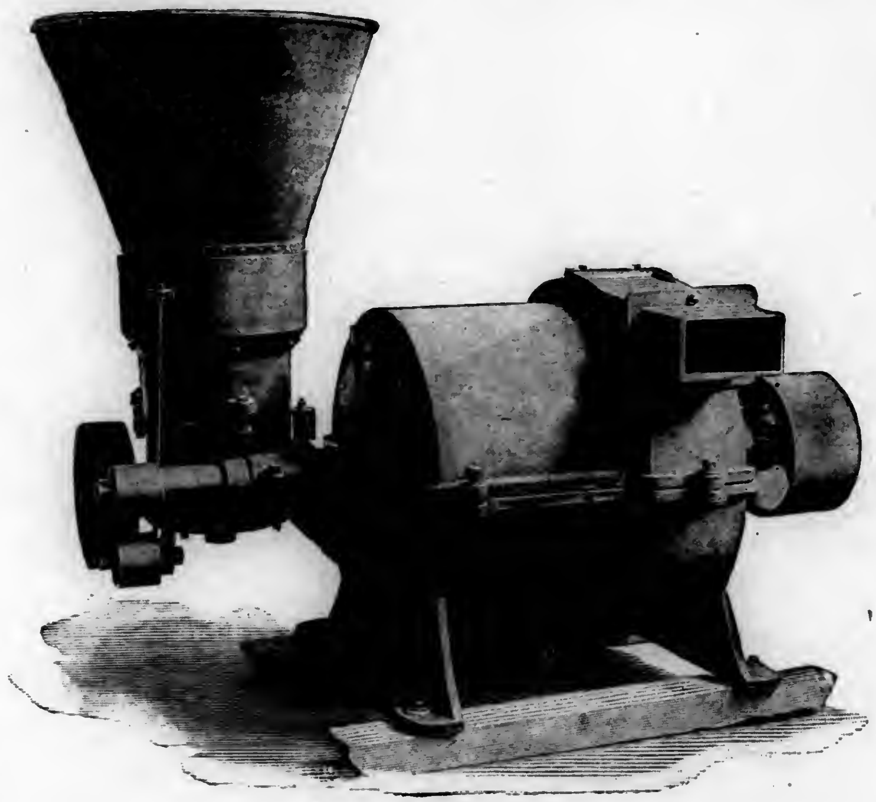


Fig. 2.

the less is required. By passing the fuel into the furnace by means of a stream of air the regulation of the elements of combustion is under perfect and convenient control, and one great advantage of the automatic stoker is attained in that there is no opening of fire doors. That the combustion may take place under ideal conditions is evident from the fact that powdered coal has been burned with the proportion of 12 lbs. of air per pound of coal, which is precisely the theoretical chemical requirement. We have also records of continuous tests showing 18 per cent. of carbonic acid gas from flue gas analysis of a powdered fuel boiler. With such conditions as these, or approaching them, increased evaporation may be expected, and is in fact obtained, over that from the same fuel burned on grates with a necessarily large excess of air. With powdered fuel there are no clinkers and the ash is apparently as fine as the powdered coal and it may be removed through pipes.

Assurance is given that lignite will work satisfactorily when pulverized, although there are no authenticated records at hand confirming it. We have seen the fact demonstrated that very poor coal, works almost as well in this process as better coal when the conditions are adjusted as they should be. There seems to be no difficulty in igniting the powdered fuel, and while it is convenient to retain the ordinary grates upon which to start a wood fire, as a preliminary to the dust firing, they are not absolutely necessary and might be removed, but where they are retained in the boiler, the change back to grate firing may be easily and quickly accomplished if for any reason it becomes necessary. As to reliability, one experimenter informs us that he has operated a stationary boiler with powdered fuel, continuously night and day for four months, without any difficulty.

In looking for the disadvantages, two come to the front and both seem possible to overcome. First, there is the cost of grinding the coal, but this may be safely figured at 25 cents per ton or less, although several early experiments were terminated on account of the expense of this part of the process. With one type of grinder now in use one horse-power is said to be sufficient to grind 100 lbs. of coal per hour. The fineness of grinding differs among the different systems and ranges from 200 mesh to impalpable powder. Formerly great difficulty was found in grinding moist coal, but this has apparently been overcome. Second, after the completion of the combustion the ash is left floating in the gases and it must be given time to settle or it will pass out of the stack as an annoying product. Careful examination of this matter seems to indicate that with the usual flame way supplied by the ordinary cylindrical return tube boiler a sufficient distance is provided in which the dust will settle before going into the tubes. Probably the change of direction of the gases at the back end of the boiler contributes to this result, because in a boiler of this kind there seems to be no more accumulation of dust in the tubes than from a grate-fired boiler, and there seemed to be no evidence about the stack of any dust. It is believed that there need be no difficulty from the ash in this type of boiler, but what the experience with locomotive or marine firing may be is yet to be learned. It has been tried in both of these services, but thus far no demonstrations have been made of its complete success in either.

The fundamental principles for the successful use of powdered coal seem to be (1) a combustion chamber maintained at a high temperature, which requires a fire brick arch to prevent the flame from impinging at once against the heat-

Results of Trials—By Bryan Donkin.

Trial.		
Experimental number	I.	II.
Date of experiment, 1895	March 29.	April 1.
Conditions, with or without Wegener's apparatus	Without	With
Duration of trial, continuous, hours	7.1	6.66
Weather	Wet	Fine and dry
Mean steam pressure (from tested Bourdon gage every quarter hour), lb	82	83.4
Coal.		
Total coal burned, lb	1,600	1,410
Coal burned per hour, lb.	225	211.5
Coal burned per hour per sq. ft. of fire-grate, lb	16.3	....
Moisture in coal, per cent	9.0	1.2
Ashes and clinkers in coal, per cent	14.8	Assumed at 15 to 19
Water.		
Mean temperature of feed water entering Boiler, Fah.	63°	48.2°
Total feed water evaporated, lb.	7,928	10,517
Water evaporated per hour, lb	1,117	1,577
Water evaporated per hour per sq. ft. heating surface lb	2.23	3.15
Evaporation.		
Lb. water evaporated per lb. wet coal, from temperature of feed, lb	4.956	7.46
Lb. water evaporated per lb. wet coal, from and at 212 deg. Fah., lb	5.90	9.00
Lb. water evaporated per lb. dry coal, from and at 212 deg. Fah., lb	6.48	9.11
Caloric value of coal, lb. water per lb. dry coal, from and at 212 deg. Fah., lb	12.00	11.85
Thermal efficiency of boiler = $\frac{\text{actual evaporation}}{\text{caloric value}}$, per cent	51	77
Chimney and gases.		
Mean position of damper	Full open	Full open
Temperature of furnace gases at end of boiler tube, Fah	above 750°	above 750°
Temperature of furnace gases at base of chimney, Fah	43[illegible]°	413°
Draft of chimney in side flue at front of boiler, inches of water	0.41 in.	Water gage oscillated from a slight pressure to a vacum.
Draught of chimney at base of chimney, inches of water	0.6 in.	
Mean analysis of furnace gases, taken every quarter hour: CO_2 p. c. by vol.	8.72	15.35
O " "	8.13	3.14
CO " "	0.88	0.0
Temperature of air in boiler house, Fah.	54°	58°
Smoke.		
Total number of times smoke observed	70	7
Total duration of smoke, minutes	105	6
Mean intensity of smoke (Mr. D. K. Clark's smoke scale), number	7	5

In this experiment the bars were rather too wide apart for the small coal used to get the best results.

ing surfaces; (2) the powdered fuel must be thoroughly mixed with the entering air, so that the air will surround the particles of coal and the fuel must be delivered in an uninterrupted stream; (3) the particles of fuel must be maintained suspended in the gases until they are completely burned, and this requires a somewhat long flame-way, for the flame must not be chilled.

When the coal is finely divided and delivered uniformly mixed with air a solid radiating flame is produced, which at first is full of particles of solid fuel in incandescence, and these rapidly disappear, leaving the larger portion of the flame merely that of burning gas. One has only to follow this flame, as the writer has done, by means of peep-holes arranged through the brick-work of an ordinary boiler setting, to be impressed with the completeness and ideal character of the combustion. The flame is that of gas rather than oil. The fuel appears to be gasified in an intensely hot atmosphere containing the right proportion of the supporter of combustion.

Different systems handle the pulverization differently. The Germans prefer to powder the coal in one place and deliver to the feeding machine in bags, while in this country the neater and safer process of pulverizing the coal as it is used is generally followed. A large amount of finely powdered coal may or may not be dangerous in storage, but there seems to be a decided advantage in carrying the dust directly from the pulverizer into the furnace, because this permits of the most perfect aeration, and this is essential. The power for grinding is applied in various ways, either by belt driving from a small steam engine or by connecting a steam turbine directly to the grinder. The grinding is usually in two stages, the first bringing the coal to about the size of split peas and the second completing the process. The fine grinding seems to be accomplished best by attrition in a cylinder filled with rapidly revolving vanes, and from this cylinder a blower takes the dust into the furnace through a tuyere, which is filled with partitions parallel to the current for the sake of obtaining the uniform mixture and for spreading and concentrating the delivery as desired.

At least four different systems seem to be giving promising and, we may say, satisfactory results. Of these the Wegener process has made considerable headway in Germany and in England. This process was described and illustrated in this journal in July, 1896. The results of trials made on a Cornish boiler by Mr. Bryan Donkin at that time are reproduced in the accompanying table.

In the Wegener process the powdered coal is delivered to the feeder in sacks. The fire doors and ash pit openings at the front of the boiler are closed and the natural draft of the chimney is used to deliver the coal dust to the furnace through a large duct, over which the dust hopper is mounted. In the duct is an air turbine driven by the natural air draft,

Fig. 3.

and this operates a revolving sieve and a tapper whereby the dust is shaken down into the stream of air, by which it is carried into the furnace. The results of the trials indicate a decided superiority of the dust fuel over the same coal burned upon a grate a few days before in the same boiler. No extraordinary performance is claimed for the Wegener process, but this test would indicate that its commercial advantages depend largely upon the cost of powdering the coal. As far as smoke is concerned, it is perfectly satisfactory.

Another German process, the Schwarzkopff, is particularly interesting just now, because of experiments which are being conducted with it by Mr. Wm. Renshaw, Superintendent of Machinery of the Illinois Central, upon one of the furnaces at the 14th Street Power House of that road in Chicago. The plan of this device is shown in the accompanying engraving, Fig. 1. Mr. Renshaw is not ready to express an opinion pending the results of tests which are now under way, but he evidently considers that there is something in the process and promises the results when the tests are completed.

The Schwarzkopff feeder is attached to the furnace front and consists of a hopper containing the pulverized coal, a rapidly revolving brush to feed the coal through an opening into the furnace, and an air opening for the control of the air. The regulation of the delivery of the fuel is had by the

small hand wheel which controls the opening through which the dust passes to the brush.

The Ideal Fuel-Feeder Company, 164 Montague Street, Brooklyn, have been engaged for several years in developing a pulverized coal system, and the writer recently examined it as applied to a cylindrical return tube boiler in commercial operation in Brooklyn and was impressed with the whole idea, as no one can fail to be who will take the trouble to investigate it.

The boiler is of 90 nominal horse-power and supplies steam at 80 lbs. pressure. The stack temperature is about 400 degs. The boiler was taken as it stood when used for grate firing, and the machine shown in Fig. 2 was applied as indicated in Fig. 3. A small vertical stationary engine and a belt to the pulverizer completed the equipment and a return to grate firing may be made in five minutes, plus the time required to start the grate fire. After watching the stack for two hours we can say that the combustion is absolutely smokeless as regards black smoke. There was at times a light-gray mist near the stack, but less in amount and of about the character of the whitish haze from a stack of a coke fire. Prof. D. S. Jacobus, after a test, says of it: "At times there was no smoke visible at the stack, and the smoke which did appear under some conditions of the fire was of a very light character, being in the nature of a gray mist extending but a few feet from the chimney. When working under proper conditions there was little or no smoke produced."

On the day of our inspection Clearfield bituminous coal was used, which has about 75 per cent. fixed carbon and 20 per cent. of volatile matter. The crusher and pulverizer require about six horse-power, but this machine has a range of capacity from 200 to 900 lbs. of coal per hour, which is hardly a fair test of the power consumed by the pulverizer, because its capacity is much greater than that of this boiler. A glance at the engravings will show that the machine is in three parts, the grinder, the pulverizer and the blower. The success of this system seems to be chiefly in the satisfactory aeration of the fuel, and its uniform delivery. Experiments are now being undertaken to determine the possibility of firing several boilers from one machine, and if the dust can be delivered uniformly to several furnaces a long step in the direction of practical application to boiler plants will have been taken. It is also the intention to apply it to locomotive and marine practice, where a wide field awaits a successful system. We have records of evaporative tests with Clearfield coal, showing 10.48 lbs. of water per pound of coal, the feed water being at 72 deg. F. The same coal has given about 6 lbs. on the grates of this boiler.

The efficient lighting of freight yards at night is a difficult problem, and one which has as yet been solved in but few cases. Good lighting is most desirable to facilitate the work of carding the cars and carrying on the various switching movements, but the conditions are very unfavorable. Electric lighting is in many ways the most satisfactory, but great care needs to be taken in placing arc lights so as to avoid long shadows as far as possible. This means the use of very tall poles. With lights badly set, the alternations of patches of bright light and moving shadows of intense blackness (by contrast) are probably more dangerous than a uniform darkness to which the men's eyes become more or less accustomed. The writer has in mind a case where the electric light was introduced in a dock shed formerly lighted by gas jets and hand lamps. The general effect was surprising; the whole shed seemed to be light. The intense shadows, however, were at first a great source of annoyance to the men trucking loads, and when they began to get used to them, several accidents occurred through men stepping off the edge of the dock in the shadows. As a result, the entire arrangement of the arc lamps had to be changed, by placing the lamps as high as possible and so distributing them as to prevent the long and intensely black shadows which existed under the original arrangement.—E. E. R. Tratman, Western Railway Club.

FAST RUNS ON THE LEHIGH VALLEY.

Black Diamond Express.

During the period from October, 1897, to July last, the "Black Diamond" express of the Lehigh Valley has made a number of fast runs which have been tabulated by the passenger department and are reproduced in the accompanying table:

FAST RUNS MADE ON LEHIGH VALLEY RAILROAD.

Distances Over 100 Miles.

Train.	Date.	From	To	Dist.	Actual time, mins.	Speed per hour.
9	July 20, 1898.	Sayre	Buffalo	177	169	63
9	July 24, 1899.	Sayre	Buffalo	177	170	62

Distances 50 to 100 Miles.

Train.	Date.	From	To	Dist.	Actual time, mins.	Speed per hour.
10	Oct. 11, 1897.	Easton	So. Plainfield	50.4	48	64
10	Oct. 16,	Easton	Parkview	65.6	60	66
10	June 6, 1898.	Easton	Parkview	65.6	61	62
9	Jan. 9, 1899.	Manchester	Buffalo	88	86	61
9	Mar. 22,	Manchester	Buffalo	88	85	62
10	Mar. 23,	Buffalo	Manchester	88	83	64
10	Nov. 2,	Wende	Manchester	69	61	65

Distances Under 50 Miles.

Train.	Date.	From	To	Dist.	Actual time, mins.	Speed per hour.
9	May 15, 1899.	So. Somerville	Landsdown	19.5	16	73
9	May 20,	Laceyville	Rummerfield	18.9	14	82
10	June 21,	Wysox	Wyalusing	16.8	14	73
9	July 18,	Laceyville	Wysox	26	22	72
9	Aug. 19,	Laceyville	Homet's Ferry	15	12	75
10	Oct. 13,	Rummerfield	Laceyville	18.9	15	76
9	Nov. 3,	Alpine	Geneva Jct.	43.9	33	80
9	Feb. 12, 1900.	Hinman,	Geneva Jct	44.9	37	73
9	Feb. 19,	Alpine	Kendaia	34	25	82
9	Mar. 22,	Batavia	Depew Jct	27.5	23	70
10	July 3,	Homet's Ferry	Laceyville	15	12	75
9	July 21,	Alpine	Kendaia	34	23	89
10	Oct. 5, 1897.	Musconetcong.	Three Bridges	15.4	12	77
10	Oct. 9,	Three Bridges	Bound Brook	15.5	11	85
10	Oct. 13,	Homet's Ferry	Laceyville	15	11	82
9	Oct. 16,	Wyalusing	Wysox	16.8	13	78
9	Oct. 18,	Pt. Reading.	Landsdown	21.9	18	71
10	Oct. 21,	Musconetcong.	Bound Brook	30.9	26	71
9	Nov. 1,	Wyalusing	Wysox	16.8	14	72
9	Nov. 11,	Hector	Kendaia	17.6	12	88
10	Dec. 11,	Towanda	Laceyville	30	25	72
9	June 9, 1898.	Parkview	So. Plainfield	15.2	14	66
10	Jan. 13,	Musconetcong.	Three Rivers	15.4	13	66
9	Aug. 6,	So. Somerville.	Landsdown	19.5	17	69
9	Aug. 9,	Parkview	So. Plainfield	15.2	13	70
10	Aug. 31,	So. Plainfield	Parkview	15.2	13	70
9	Oct. 3,	Burdett	Kendaia	22.9	17	82
9	Oct 17,	Alpine	Kendaia	34	26	79
9	Dec. 16,	Laceyville	Rummerfield	18.9	15	76

The regular schedule of this train is, westbound, New York to Buffalo, 448 miles, 9 hours and 55 minutes, including the ferry and 13 stops. Deducting time consumed by the ferry and stops, the actual running time of the train between Jersey City and Buffalo, 447 miles, is 9 hours and 12 minutes.

The regular schedule of the train, eastbound, Buffalo to New York, 448 miles, is 10 hours and 3 minutes, including ferry and 13 stops. Deducting the time consumed by ferry and stops, the actual running time of the train between Buffalo and Jersey City, 447 hours, is 9 hours and 20 minutes.

Especial attention is called to the fast run made by train No. 9 on July 21, 1900, Alpine to Kendaia, a distance of 34 miles in 23 minutes, or a speed of 89 miles per hour. Another instance is shown on November 3, 1899, where train No. 9 ran 43.9 miles in 33 minutes, this being 80 miles an hour.

It is understood that these figures are taken from the train sheet records.

The first of the new Monitors, the "Arkansas," was launched at Newport News, November 10. These vessels will have a single balanced turret forward, with 9 in. of steel armor and equipped with two of the new type 12-in. guns. They will also have four 4-in. rapid-fire guns, three 6-pounders, and four 1-pounders.

AIR BRAKE HOSE SPECIFICATIONS.

Belgian and French Railroads.

In connection with the discussion on brakes and couplings before the International Railway Congress, Mr. J. Doyen, Engineer of the Belgian State Railways,* presented some of the details of foreign practice with regard to air-brake hose which will interest our readers who have been concerned by the great expense of hose maintenance. Mr. Doyen speaks of the hose as being mainly responsible for the maintenance charges of the brakes. Many foreign roads have adopted hemp coverings to protect the hose, and the French Northern has increased the life of the hose 50 per cent. by varnishing and tarring it before applying the covering. Mr. Doyen concludes his paper with extracts from the specifications of several roads which we reproduce from the record.

The Belgian State Railways specify as follows: The density of the rubber shall be at least 1.10 and it shall be vulcanized by means of sulphide of antimony. The rubber shall, without losing its qualities, support a dry heat of 266 deg. Fahr. for one hour, and a moist heat of 320 deg. Fahr. for three hours; it shall leave when burnt 42 to 45 per cent. of ash composed of equal parts of oxide of lead (litharge) and oxide of zinc. The canvas used in making the tubes shall be up to sample. The tubes must be capable of being placed without tearing on a mandrel the maximum diameter of which is 1⅜ in. for tubes the interior diameter of which is 1 1/16 in., and 1⅝ in. for those of 1¼ in. diameter. Tubes of 1 1/16 in. interior diameter are made with four layers of cotton canvas, those of 1¼ in. with five layers. The tubes must be provided at each end with a ring of rubber 2/25 to 3/19 in. thick; plunged in water and filled with air at a pressure of ten atmospheres they must not deteriorate and no air bubbles must escape. The tubes are to be guaranteed for two years and a half.

On the French Eastern Railway the pressure test is limited to 7 kilograms per square centimeter (99.6 lbs. per square inch), and the tubes are guaranteed for two years.

The French Southern requires special tests. A sample of the rubber reduced to small pieces and heated in a drying oven to 275 deg. Fahr. for six hours, must remain elastic, and must not become brittle or alter its properties. Another sample placed in chlorine at 68 deg. Fahr. for twenty-four hours must not harden or crack on the surface. A third sample must not crack or change its shape if heated for an hour to 248 deg. Fahr. in the mineral oil called "Mazout." The proportion of mineral matter and ash contained in the rubber must not be greater than 45 per cent. Under the action of a solution of caustic soda in alcohol, the rubber must not lose more than 15 per cent. of the weight of pure rubber it contains. Washed afterward in nitrobenzene the loss must not be more than 35 per cent. of the same weight of pure rubber. These tests are to be carried out as follows:

One gram of shredded rubber is to be digested for an hour at boiling point in a flask fitted with a return condenser with a mixture of 4 cubic centimeters (0.244 cubic inch) of pure soda lye at 36 deg. Baume and 17 cubic centimeters (1.037 cu. in.) of 95 per cent. alcohol. The solid matter left is to be washed with boiling water, until the washing water is neutral, then collected on a weighed filter and dried at 100 deg. C. (212 deg. Fahr.) until the weight is constant. The weight of dry matter remaining, subtracted from one gram, will give the required loss of weight.

Let c be the percentage of ash, F the loss of weight (in centigrams) found above. Then the loss as a percentage of the weight of pure rubber will be given by the expression:

$$F \frac{100}{100 - c}$$

*Bulletin, International Railway Congress, July, 1900, page 2,175.

The insoluble residue obtained above is then to be digested for about an hour at about 20 deg. C. (68 deg. Fahr.) with 30 cubic centimeters (1.831 in.) of nitrobenzene, then filtered and washed, first with 30 cubic centimeters of nitrobenzene and then with 100 centimeters (6.103 cu. in.) of 95 per cent. alcohol. The residue is then to be dried at 100 deg. C. (212 deg. Fahr.) until the smell of nitrobenzene has disappeared.

Let A be the new loss of weight (in centigrams) thus found, then the loss due to nitrobenzene, taken as a percentage of the pure rubber, will be given by the expression:

$$A \frac{100}{100 - c}$$

The Paris-Orleans Company requires that the tubes should stand an interior pressure of 30 kilograms per square centimeter (426.7 lbs. per square inch) without permanent stretch. They must be capable of being bent to a radius of 100 millimeters (4 ins.) throughout their length, without breaking or flattening.

On the Paris-Lyons and Mediterranean Railway the tubes are in the first place slipped on to the connecting pieces, which have been painted with rubber solution. It must be possible to do this without the use of a mandrel to stretch the tube, and without tearing or stripping the rubber. The tubes having thus been provided with a metallic coupling piece at each end, are fixed to these coupling pieces by means of metal bands drawn up by a screw. They are then tested for leakage at a pressure of 10 kilograms per square centimeter (142.2 lbs. per square in.). At this pressure the increase in exterior diameter must not be more than 4 millimeters (3/19 in.). A certain number of tubes from each batch are tested for bending as described hereafter, which, filled with air at a pressure of 8 kilograms per square centimeter (113.8 lbs. per square inch), they are then tested again for leakage at a pressure of 10 kilograms per square centimeter (142.2 lbs. per square inch). For the bending tests each tube, with its coupling pieces, is put in a special machine, which reproduces as nearly as possible, by means of oscillations of 200 millimeters (8 ins.) amplitude, the deformation which the tubes undergo in practice on the coaches. The tubes are subjected to a series of 20,000 oscillations, with an interior pressure of 8 kilograms per square centimeter (113.8 lbs. per square inch). If the oscillation tests reveal no defect, and if during these tests the metallic coupling pieces at the ends of the tubes are not displaced, the tubes undergo the second leakage test at 10 kilograms (142.2 lbs. per square inch) pressure as mentioned above.

In discussing the problem of securing adequate freight house facilities in very crowded districts, in a paper before the Western Railway Club, Mr. E. E. R. Tratman expresses the opinion that there are already cases where economy would well warrant the installation of tracks on two floors, the cost of land being greater than that of the additional building and equipment. Mr. E. P. Dawley, of the New York, New Haven & Hartford Railroad, states that $2 per square foot extra, above the cost of a one-story house, ought to give a good mill-construction, slow-burning type of building two stories high. The arrangement would be easily established on a side-hill location, but could also be established in flat localities with comparatively little additional expense, and prove a profitable and economical investment. Coaling stations quite frequently have approaches of 5 to 6 per cent., or even 10 per cent., for the loaded coal cars, which are pushed up by a small dummy car on the end of a cable, or by other suitable means. At coaling piers, etc., the loaded cars—with 39 to 50 tons of coal—are sometimes hauled up inclines of 25 per cent. to the top of the pier by cables. Similar methods could be used for the freight houses, and if the low-level tracks were depressed 4 or 5 ft., the incline approach to the high level would be quite short.

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The satisfying results of awarding prizes in manufacturing plants to men who suggest the most valuable improvements and the steady increase in the practice raise the question whether the idea is not equally applicable in railroad shops. If a superintendent of motive power should be authorized to offer to the shopmen several prizes, varying from perhaps $100 to $25, to be awarded annually for the suggestions which lead to the greatest amount of saving in cost of the work, it is probable that the investment would pay handsomely, as it does in other large establishments. In a thousand workmen such as are found in locomotive and car works there must always be many bright, intelligent men whose interest might be enlisted in this way.

The locomotive of to-day is a noble production, and we are in hearty sympathy with every effort toward symmetry and beauty in design. Americans are accused of building locomotives which have the appearance of being "blasted out of the solid rock," in the pursuit of simplicity, and this in many cases amounts to an utter disregard of appearances which seems unnecessarily severe. In a recent address before the students of Purdue University, Mr. Waldo H. Marshall, of the Lake Shore, defined the conditions in working up a design as (1) Safety; (2) Efficiency and reliability in service; (3) Economy, and (4) Beauty of the whole design. Upon the last point he expressed a high and worthy ideal when he said: "The modern locomotive, with its mammoth proportions and simple outlines, its great boiler indicative of power, and its well proportioned machinery is altogether too magnificent and majestic a piece of work to leave the hands of the designer in a crude and unfinished state. A handsome locomotive hauling at high speed and apparently with so much ease a long passenger train or dragging with slower motions many hundreds of tons of freight, is a sight which pays the designer for all of his labor, and if we reflect upon the great work which the locomotive is doing, and will yet do, for mankind in the development of the resources of nations, and the extension of the bounds of civilization, we find inspiration for careful, conscientious work in the assurance that whatever can be contributed to the perfection of the locomotive is worth the best efforts of the mechanical engineer."

THE STAYBOLT PROBLEM

In the matter of staybolts one of two things is certain. They should be made so that they will not break or locomotive boilers should be so constructed that staybolts will not be necessary. Both are possible, and the exigencies of present service demand a decided step away from present practice, which is giving so much trouble. Delays to engines because of inspection and necessary replacements of broken bolts and the cost of present methods are becoming sufficiently important to demand radical treatment without consideration of the question of safety at all.

The extent of the effect of the advent of the wide firebox on this question is uncertain. It is expected to lead to an improvement, and such a plan as Mr. Gaines presents elsewhere in this issue will probably tend in the same direction. These, however they may affect the future, cannot help matters with the 35,000 or so narrow fireboxes in use in all parts of the country. These constitute a problem by themselves, and it is highly desirable that a remedy should be found to meet the needs of these, and also new fireboxes, in the same way.

Enough is known of the peculiar relative movements of the inside and outside firebox sheets to show the necessity for flexibility in the staying, and it has been said that, if the ends could be properly secured in the sheets, wire rope stays would be ideal. Perhaps they would, but it is now believed to be doubtful whether the typical sling stay so long used for crown sheets would not be even better, because it permits of a slight approach of the sheets toward each other. This is held to be a necessary feature by one who has experimented with staybolts and stuffing boxes to measure these movements. Mr. J. B. Barnes, Superintendent of Motive Power of the Wabash Railroad, has kindly enabled us to illustrate and describe in this issue an important improvement in staybolts which he has devised after an experience of thirty-five years, and he has taken a great deal of trouble to give us a thorough description. He believes this design to fully meet the needs, and furthermore says:

"We have removed and replaced in the fireboxes of 30 of our high-pressure engines between January 1 and September 1, 1900, 3,100 staybolts of ordinary design, and we use in staybolts of our make the best material we can get for the purpose. On a road with large and closely assigned equipment the aggregate detention to engines on account of renewals of staybolts is a very important and expensive item. Taking engines out of service for this purpose and substituting others interferes with traffic and takes time which is very valuable, in addition to the large expense of repairs."

In previous issues* we have endeavored to inform our readers of progress in staybolts. At present a flexible connection with the outer sheet seems to be the most promising factor. These bolts will cost more than ordinary ones to instal, but if they do not break, the expense is justified. We do not believe that present common practice in staybolts will be perpetuated or even defended much longer.

*American Engineer and Railroad Journal, September, 1897, page 319; December, 1899, page 382; and January, 1900, page 3.

CORROSION OF STEEL CARS.

Apparently Not a Cause for Anxiety.

If cars made entirely of steel are to have short lives because of corrosion, it is important to know it, because of the numbers which are being built. We considered the subject sufficiently important to secure an expression of opinion from a railroad mechanical officer whom we consider the best authority to be had. His experience covers the period of a little more than two years since the beginning of large orders for steel coal cars, and he finds no evidence that they are being injured by corrosion. He does not say that there has been no corrosion at all, for in the case of a small number of cars which stood on a side track loaded with soft coal for 90 days, some of the hopper plates and door fixtures were corroded, but not more than was to be expected. In fact, as much trouble has been experienced with wooden cars under similar conditions. Sometimes the door fixtures and truss rods of wooden cars have suffered; also the trucks and even the rails. This officer, who, for obvious reasons, does not wish his name used, believes that his experience has been long enough, and we know it has been wide enough, to develop the weakness if it exists. His opinion is reassuring.

In France (see the American Engineer, Vol. LXX., page 171, 1896) Mr. Tolmer, in 1896, found that steel frame cars showed the following proportional losses in section from corrosion and rust:

Cars built in	Life.	Loss in per cent
1869	27 years	6.0
1874	22 years	4.0
1875	21 years	3.18

In the same year, 1896, Mr. E. M. Herr, then Assistant Superintendent Motive Power of the Chicago & Northwestern, found that iron locomotive tender frames showed a waste of from 10 to 15 per cent. in section in service varying from 9 to 17 years, the exposure to the weather being noticeably severe upon them, and the use of paint almost wholly neglected. Mr. Tolmer recommends painting steel cars every three years and if this is carefully done the structures are expected to last from 40 to 60 years in France, which is long enough for any part of railroad equipment to become obsolete several times over. Locomotive tenders are subjected to infinitely more severe service than that of coal cars, and there has never been a question of what material should be used for their construction. Neither is wood considered as a better material for the coal space of tenders. If a steel car is thoroughly painted every three years the life of the understructure will be indefinite and, except for repairs due to wrecks, there should be a little expense required, probably much less than with wooden cars. The cost of repairs to a wooden car averages about $40 per year (Interstate Commerce Commission Statistics), and it is probable that this amount per year will be more than enough to keep steel cars in good condition for several times the life of wooden structures. It has been pretty well established that with wooden cars the repair expense may be divided as follows: Body, 36 per cent.; trucks, 32 per cent.; draft gear, 32 per cent. The trucks and draft gear being common to both, will balance each other, and there remains a steel car body to be maintained against a wooden one for 36 per cent. of the total cost of repairs. It is reasonable at least to expect this ratio to be maintained, and it is probable that the total cost will not be increased by the steel cars in spite of the fact that they carry more freight and are generally used more continuously than the wooden cars.

It is important to design steel cars to prevent the bending or "working" of the plates near the joints because of the opportunity for corrosion which such bending offers. The draft gear question is also important, and much more so as the capacities increase. Those ordering large steel cars, or large capacity cars of any type, should take up this question carefully or their draft gear troubles will enormously increase.

Summed up in a few words, the situation seems to warrant this conclusion: That steel cars, or any other cars, should not be used for the storage of soft coal, for any length of time, particularly where exposed to the weather; steel cars should be painted thoroughly and often enough; the draft gear should be adequate to meet the demands upon it, and if these precautions are taken steel cars ought to be practically indestructible, or at least as much so as steel bridges; that is to say, they will outlive their usefulness.

THE DEPTH OF WIDE FIREBOXES.

In heralding the advent of the wide firebox for soft coal burning, in the November number, we have been taken to task concerning the omission of a consideration of the depth of the firebox. A correspondent who is securing most satisfactory results with wide fireboxes and is enthusiastic in their praise, fears that in the desire to secure adequate grate area the importance of depth in the firebox will be neglected. He insists that, for soft coal, the firebox should be both wide and deep, and he is probably entirely correct, because there appears to be every reason to believe that the more combustion space, within the limitations of the locomotive, the better. But we believe that the wide grate has so much to offer in the way of improvement that the gain due to width is greater than that to be obtained from depth. If both cannot be had, it will probably be found best to get the width at a considerable sacrifice of depth. We have particularly in mind the six-coupled engine for fast and heavy passenger service, to which it is difficult to apply a wide firebox without making it very shallow. A six-coupled engine is a necessity upon roads having fast, heavy trains making frequent stops, and it is this type which seems to offer the difficulties, and it is relatively easy to secure deep fireboxes with the Atlantic type wheel arrangement. If it is possible to use a wide and shallow box over very large driving wheels the powerful passenger engine will be easy to design.

Another correspondent supports the wide and deep box. He says: "There is a distinct difference between the wide, shallow firebox, as a type, and the wide, deep firebox. The wide, shallow firebox over the driving wheels is certainly not new, but it does not seem to be well suited to bituminous coal, which comes from the mines in sizes varying from very large to very small pieces."

A Western motive power officer in commenting upon the article referred to, "Emancipation of the Grates," says: "I am firmly convinced that in high-power modern engines, up to the present time, sufficient grate area and firebox volume have not been furnished. It will be necessary to adapt the amount of grate area to the fuel, which, as stated in the article, can be accomplished by means of large areas and of dead plates, if necessary to reduce the area, and where it is necessary to use dead plates it will be rather an advantage instead of a disadvantage in that the firebox volume will be large. This will furnish an excellent combustion chamber. I think that all of the advantages of the larger grate area set forth in this article will be realized."

This gentleman is not troubled about the depth of the firebox. He says: "A reduction in depth will come with the use of wider fireboxes in some types of engines, but this, I think, will be offset by the many advantages."

A superintendent of motive power who has just ordered a number of consolidation engines with wide fireboxes, recently wrote: "I agree entirely with your views on the subject, as is evidenced by the fact that we are now having a number of heavy consolidation engines built with wide fireboxes giving nearly 50 sq. ft. of grate area. The recent experiments with the C. & N. W. engine seem to demonstrate beyond argument the possibilities of economy inherent in the design. The only adverse condition which should be apprehended is in the case of engines whose service requires them to stand under steam for a large part of the time with a correspondingly small time of active work. Under such conditions it may be more eco-

nomical to burn fuel at high rates of combustion during the relatively brief period of maximum work, in order to avoid excessive standing losses.

"To the motive power official one of the most attractive features of the wide grate is the possession of engines which may be depended on to steam freely with any grade of fuel. There can be few such who have not been at times exasperated by the constant reports of trains delayed by low steam, due to poor coal. Lack of uniformity in quality of fuel is a condition which must be accepted and faced, and the large grate is at present the most hopeful solution of the problem.

"The most interesting question as to the development of the type is in regard to the practicability of designing heavy freight engines in which high tractive power requires a large percentage of total weight to be carried on the driving wheels. In such designs, trailing wheels are out of the question, and careful design is needed to reach the most harmonious adjustment of parts, since a sufficient depth of firebox must be obtained without raising the boiler excessively, and at the same time the firebox must be elevated above the drivers. That the problem is not incapable of solution is demonstrated by several recent designs, as to the success of which I believe there is little room for doubt. I think your article an excellent one. You have not stated the matter at all too strongly."

Another who has ordered a large number of wide-firebox engines says: "I think you have covered the subject in an admirable manner. I indorse every word of your article on wide grates. The wide firebox and large grate surface for bituminous coal have come to stay, I believe, and I believe that they will give opportunities for increased capacity of locomotives in passenger and freight service."

The effect of depth of firebox upon combustion is now chiefly a matter of opinion and the subject needs investigation. To secure ideal firebox conditions the depth, as well as the area, needs to be made to fit the coal. Anthracite, with its short flame, requires comparatively little combustion space, while all long-flaming fuels require more. If coals could always be selected, those high in fixed carbon would be favorites because the heat would be developed close to the fire, and the heat developed near the fire has a longer journey before becoming cold by contact with the tubes.

The three coals in the following list evidently require rather different firebox conditions:

	Fixed carbon.	Volatiles.
Pocahontas	75%	18%
Hocking Valley	46%	36%
Streator	44%	39%

Such wide differences in fuels support the contention that each superintendent of motive power will need to study the special conditions which he has to meet. It is reasonable to suppose that Streator and Pocahontas should not be expected to give equally good results in the same firebox. The former requires greater depth. We believe that the best development of the firebox and combustion is only begun and that there is more improvement to be had from this than from any other factor of locomotive design. Its importance is twofold, because greater efficiency of combustion means saving of money and also increase of capacity of the locomotive, which will amount, in the end, to the same thing.

TIGHT TRAIN PIPES AND UNIFORM PISTON TRAVEL.

Two Air Brake Factors Requiring Attention.

The writer recently examined a recording gauge diagram from the train pipe of a 30-car train, of air-braked cars, which showed a 35 minute struggle of the air pump, an old and small one, to charge the train reservoirs after a rather severe application. A larger pump would have reduced the time, but the chief trouble seemed to be in a large number of small leaks in the train pipe and couplings. There are two good reasons for investigating and remedying such conditions, first, on account of the impaired efficiency of the brakes, and, second, because of the drain on the locomotive boiler to drive the air pump. Messrs. Petrie and Sheldon spoke plainly on this subject before the Railroad Club in Buffalo last month, and indicated a condition of air brakes requiring immediate attention. They stated that with a slight leakage at the couplings, especially if the air pump is not the largest and latest, it is usually necessary to "cut out" air-braked cars in order to get any service. They direct attention to faults with the couplings, and say: "The gaskets are continually wearing out, showing that they should have a larger bearing surface where they come together, or made of a different material, to make a larger surface." They suggest larger couplings or the enlargement of the gasket in the present coupling.

The necessity for economizing in the use of air becomes more important with the increasing number of air-braked cars and the loading of the locomotives up to their full capacity. Also the exacting character of present-day train service demands the utmost of the brake gear. For these reasons the brake-slack adjuster is becoming daily more important. The gentlemen referred to also gave this a high place in the list of necessary improvements. Differences in piston travel cause differences in the force of application of the brakes, and consequently shocks in the train. With long piston travel the brakes are less efficient, because of the greater space behind the piston to be filled with air, and the consequent lower pressure of air secured by a given amount of reduction. Long piston travel wastes air in two ways. A car having a 6-in. piston travel and a train line pressure of 70 lbs. requires a 16-lb. reduction to give a cylinder pressure of 54 lbs. A car with a 9-in. travel requires a reduction of 22 lbs. to give a brake cylinder pressure of only 48 lbs. This may mean a waste of one-third of the air pumped. It is to be overcome by the use of automatic slack adjusters. A satisfactory brake adjuster is available and waiting for those who are ready to invest in it.

LOCOMOTIVE BOILER EXPLOSION.

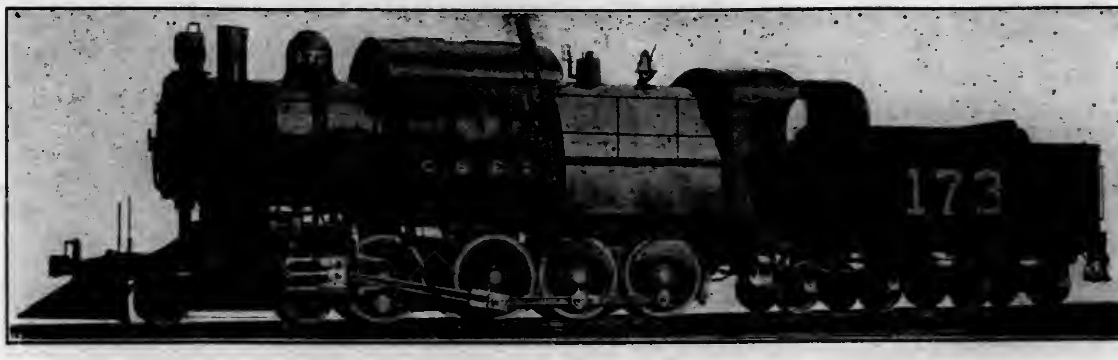
Great Eastern Railway, England.

An interesting boiler explosion which occurred September 25, at Westerfield station on the Great Western Railway, England, is described in "The Engineer" by aid of a number of engravings. The engine, which was nearly new, had just hauled a rather heavy freight train up an incline, and the safety valves, which were set at 160 lbs., were blowing off at the time.

The plates showed no signs of overheating, the staybolts were not broken, and there seemed to be no evidence of poor material. The firebox appears to have given way inside, at the side and below the water level, in fact quite low down; it ripped inward, tearing away from the stays until the crown was reached. At this time the strip torn must have been free from the mud ring, from which it tore away in the solid plate and not through the rivet holes. Eighty-eight of the crown bar bolts were broken. According to the account of the examination, the events appeared to be as follows:

(1) A rent is made in the side of the box, through which water rushes out; (2) the pressure in the boiler being reduced, a portion of the water is flashed into steam; (3) this flashing process being once started, it goes on, until in the twinkling of an eye a pressure is produced great enough to tear up the firebox.

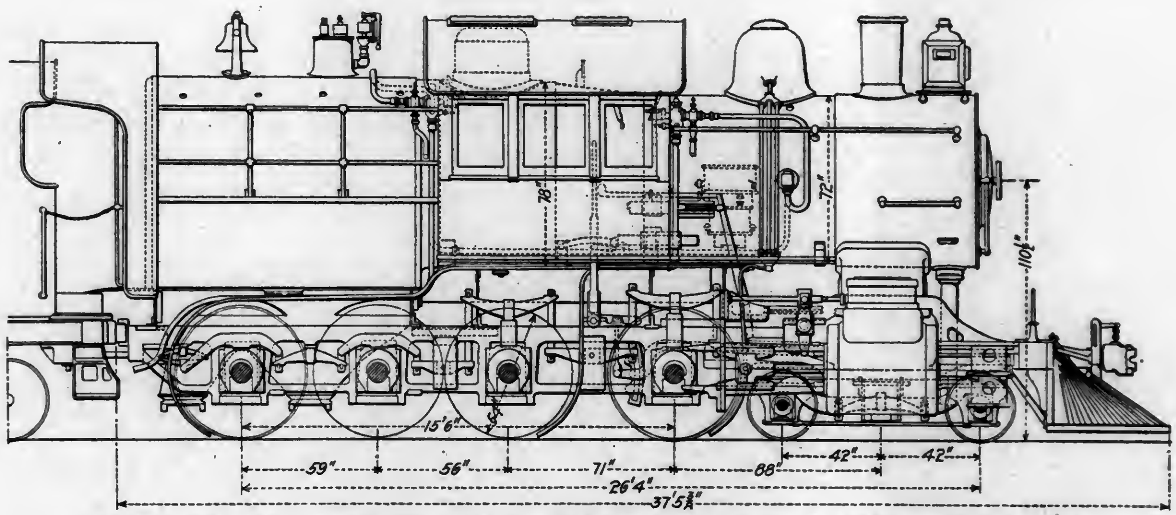
The firebox was of a good quality of copper. It may have been too good; that is to say, so pure that it was too soft, and a cheaper and poorer grade might have held intact. The staybolts were not riveted over at the ends. They were drilled and the threads closed tightly into the sheets by a drift. The fact that many of them pulled through the sheet indicates the probability that it would be better to rivet them. It is difficult to account for the initial fracture of the firebox sheets, and the only reasonable explanation seems to be that the plate pulled away from the staybolts and then the events occurred as already stated.



TWELVE-WHEEL TWO-CYLINDER COMPOUND WITH WIDE FIREBOX.

PITTSBURG LOCOMOTIVE WORKS. CHICAGO & EASTERN ILLINOIS RAILROAD.

Weights: Total of engine............189,700 lbs.; on drivers............150,000 lbs.; total of engine and tender............287,700 lbs.
Wheel base: Driving............15 ft. 6 in.; total of engine........ 26 ft. 4 in.; total of engine and tender.........51 ft. 2 in.
Cylinders: 21½ and 33x30 in. Wheels: Driving....... 54 in.; truck...... 28 in.; tender........33 in.
Boiler: Diameter .... 72 in.; boiler pressure............ ...200 lbs.
Firebox: Length............108 in.; width..............96 in.; depth front.... ....71⅝ in.; back..........59⅝ in.
Grate: Area.... .... 72 sq. ft. Tubes: 300; 2 in., 14 ft. 6 in. long.
Heating surface: Tubes.... .... 2,265.6 sq. ft; firebox...... 181.4 sq. ft.; total ....2,447 sq. ft.
Tender: Eight-wheel; water capacity............4,500 gals.; coal capacity............10 tons.



Twelve-Wheel Two-Cylinder Compound, with Wide Firebox—Chicago & Eastern Illinois Railroad.

TWELVE-WHEEL TWO-CYLINDER COMPOUNDS.

With Wide Firebox for Soft Coal.

Chicago & Eastern Illinois Railroad.

The Chicago & Eastern Illinois has just received five locomotives from the Pittsburg Locomotive Works. They are two-cylinder compounds, with a grate area of 72 sq. ft., which is larger than that of recent engines with wide grates for soft coal. The cylinders are 21½ and 33 by 30 in. and the driving wheels 54 ins. in diameter. The grate is 9 ft. long and 8 ft. wide, and, owing to the width, the cab was placed in front of the firebox. The new engines have been running about six weeks, which is too short a time for an estimate of their qualities. These engines have Mr. Wightman's form of cylinder and frame construction which was used on the very large Pittsburgh, Bessemer & Lake Erie engines (American Engineer, July, 1900, page 214, and September, page 280). The frames are of cast steel and special attention was given throughout to their strength and lateral bracing. The brake shoes are behind the wheels. The links are placed as near the forward axle as possible and a motion bar, offset to clear that axle, connects to the rocker arm which is very close to the cylinder. The diagram and photograph make this construction clear. The combination of the wide grates and compounding may be expected to give a good account of itself. The following table gives additional information:

Twelve-Wheel, Two-Cylinder Compound, Chicago & Eastern Illinois Railroad.

Wheel base, total, of engine	26 ft. 4 in.
Wheel base, driving	15 ft. 6 in.
Wheel base, total, engine and tender	51 ft. 2 in.
Weight on drivers	150,000 lbs.
Total weight in working order	189,700 lbs.
Cylinders	21½ and 33 by 30 in.
Driving wheels, diameter	54 in.
Heating surface, firebox	181.4 sq. ft.
Heating surface, tubes	2,265.6 sq. ft.
Heating surface, total	2,447 sq. ft.
Grate area	72 sq. ft.
Boiler diameter	72 in.
Boiler pressure	200 lbs.
Firebox, length and width	9 by 8 ft.
Firebox, depth, front and back	71⅝ and 59⅝ in.
Height, center of boiler above rails	9 ft. 2½ in.
Height of stack above rails	15 ft.
Drivers, material of main centers	Cast steel
Drivers, material of other centers	Steeled cast iron
Truck wheels, diameter	28 in.
Journals, driving axle, size	8½ by 10 in.
Journals, truck axle, size	5½ by 10 in.
Piston rods, diameter	4 in.
Kind of piston-rod packing	Metallic
Steam ports, length	H.-P. 18 in., L.-P. 21 in.
Steam ports, width	H.-P. 1⅜ in., L.-P. 2 in.
Exhaust ports, length	H.-P. 18 in., L.-P. 21 in.
Exhaust ports, width	H.-P. 3 in., L.-P. 3⅛ in.
Bridge, width	1⅜ in.
Valves, kind of	Balance slide valves
Valves, greatest travel	H.-P. 5 in., L.-P. 6 in.
Valves, outside lap	1 in.
Valves, lead in full gear	1/16 in.
Boiler, type of	Wootten extended wagon top
Boiler, thickness of material in barrel	11/16 and ¾ in.

Seams, kind of horizontal	Sextuple riveted
Seams, kind of circumferential	Lapped and double riveted
Thickness of tube sheets	½ in.
Thickness of crown sheets	7/16 in.
Crown sheet stayed with radial stays	
Dome, diameter	32 in.
Firebox, material	Steel
Firebox, water space	Front 4 in., back 3½ in., and sides 3 in.
Grates, kind of	Cast iron, rocking pattern
Tubes, number	300
Tubes, material	Charcoal iron
Tubes, outside diameter	2 in.
Tubes, length over sheets	14 ft. 6 in.
Smokebox, diameter	73 in.
Smokebox, length	60 in.
Exhaust nozzle	Single
Exhaust nozzle	Permanent
Exhaust nozzle, diameter	4½, 4¾ and 5 in.
Exhaust nozzle, distance of tip above center of boiler	9 in.
Stack	Straight
Stack, inside diameter	16⅞ in.
Stack, height above smokebox	2 ft. 9 in.
Tender.	
Type	Swivel truck
Thickness of sheets	5/16 and ¼ in.
Type of under frame	Steel channel
Type of truck	Fox pressed steel
Type of truck spring	Elliptic
Diameter of truck wheels	33 in.
Diameter and length of axle journals	5 by 9 in. (M. C. B.)
Tender weight, loaded	98,000 lbs.
Tender water capacity	4,500 gals.
Tender coal capacity	10 tons.

PORTABLE STEAM HEATING PLANTS.

Chicago & Northwestern Railway.

A convenient and profitable arrangement for caring for the steam heating plants for passenger yards at terminals and other large stations has been devised on the Chicago & Northwestern Railway. It is in the form of an old locomotive boiler mounted on an old 32-ft. 15-ton flat car with a suitable housing. It may be disconnected from the permanent piping and sent to the mechanical headquarters at the approach of warm weather for repairs and storage until again needed in the fall.

The boiler is supported on the car with the firebox projecting through a hole in the floor, the ash pan being below the line of the sills. One end of the car is partitioned off for coal supply, and temporary water pipes are laid and protected against freezing. The boiler is fed by injectors and the steam is led through the passenger yards by underground pipes for heating the cars. The location is chosen so that it will not be necessary to move the steam heating car during the entire winter. The illustration shows one of them as fitted up for the W. & St. P. division. A number of them are in use, and they appear to be generally satisfactory. The arrangement of windows and doors is clearly shown in the engraving, which was made from a photograph received from Mr. G. R. Henderson, Assistant Superintendent of Motive Power of the road.

These cars have been arranged for the reception of the boilers by Mr. C. A. Schroyer, Superintendent of the Car Department.

Steam Heat Car for Passenger Yards—Chicago & Northwestern Railroad.

HAND VS. PNEUMATIC RIVETING.

In our November number a comparison was made between hand and pneumatic hammer riveting on a locomotive firebox, showing the marked saving in cost by the latter method. We have further figures on the same subject comparing the cost of driving ⅞-in. rivets per day of 10 hours by hand and per day of 8 hours by the long-stroke riveting hammer. The figures are arranged for comparison as follows:

Hand Driven.		
2 Strikers at $3 each	$6.00	
1 Holder-on at $2.50	2.50	
1 Heater at $1.25	1.25	
Total	$9.75	
Average number of rivets driven, 375, at $9.75		$0.0260 each
Hammer Driven.		
1 Machine operator at $2.50	$2.50	
1 Holder-on at $2.50	2.50	
1 Heater at $1.50	1.50	
1/12th salary of engineer, 8 hrs. at 25c	.1666	
1/12th salary of fireman, 8 hrs. at 17½c	.1166	
1/12th cost of fuel at $2.50 per day	.2080	
Total	$6.9912	
Average number of rivets driven, 780, at $6.9912		0.0089 each
Saving per rivet driven		$0.0171 each
Saving		65 per cent.

These costs are taken from the records of several months' work, and they are believed to fairly represent what may be done anywhere under ordinary conditions. This work was done by the Boyer long-stroke riveting hammer, manufactured by the Chicago Pneumatic Tool Company.

The pension system has worked so well on the Pennsylvania Railroad that commencing January 1 it is to be extended to the Pennsylvania Lines West of Pittsburg. After that time all employees who reach the age of 70 years will be retired upon pensions amounting to 1 per cent. of the regular monthly pay for the ten years preceeding retirement for each year of service. If a man has had $100 per month for the last 10 years of his service, which covers 30 years in all, he retires on a life pension of $30 per month. When this plan goes into effect no person will be taken into the employ of the Pennsylvania System who is over 35 years of age unless by action of the Board of Directors. Such a pension plan may be expected to insure contentment and steadiness among the men and a relief from anxieties concerning labor struggles. It is humane, it is honest and altogether good business policy.

CORRESPONDENCE.

DECAPODS AND COMPOUNDS.

To the Editor:

I am much interested in the data supplied in the American Engineer for October, page 319, in specification and illustration of the new heavy four-cylinder compound locomotive of the "Soo Line," and which we would better recognize by its original class as "decapod" than as you have it, a "12-wheel"; at least, those most accustomed to them will so continue to class them.

The decapod is a class well adapted for the modern ideas of heavy weights, large boilers, wide fireboxes, large heating surfaces, high pressure, etc., where, in freight service, there is work to do at speeds within their necessarily low driver capacity, which, in an engine of this class and 55-in. drivers, will be under 25 miles per hour. To illustrate the facility of adaptation of the decapod to heavy and difficult situations of service, I will state that some years ago—1887—the decapod was supplied to the Northern Pacific road for use in mountain construction work and was used during two entire years on heavy grades and curves, on and through the Cascade range and tunnel construction, and became favorites with the engineering corps, who had entire control of them during that time. These decapods were lighter and of less capacity than the engine you illustrate, being plain, simple machines, 22 by 26-in. cylinders with 45-in. drivers, 2,310 sq. ft. heating surface, 140 lbs. steam pressure and 140,000 lbs. weight on drivers, with a driving wheel base of 17 ft. and the gauge of wheels compensated to render easily on the construction curves, which they did admirably.

Undoubtedly the compound feature of the "Soo Line" engine contributes largely to the success which your figures indicate, as they are given in the table of comparison with one of the heaviest class of simple engines, and propably compounding is responsible for its economy in tonnage cost per mile, and its splendid showing of relative capacity in effort made. This comparison and result brings plainly into contrast the relative merits of a simple and compound engine of nearly equal power; and, taken by itself, no doubt is correct in conclusion. There have, however, been recent instances of successes in each of these types which will perplex the average mind to decide between them. The "Northwestern" type simple engine with wide firebox, piston valves, high pressure and ample heating surface, show an economy in fuel of 20 per cent. over other engines, and this is their regular daily performance; while, on the other hand, the Chicago, Rock Island & Pacific new compounds, both freight and passenger, are capable of doing, and have done, 33 per cent. more work in tonnage hauled than other engines of the simple type, and with the same expense for fuel. In both of these instances the engines are worked up to their best effort.

To be correct in estimates of value of types, there should be given to each, all desirable features of design applicable to their type. Simple engines, for instance, referring to the C. & N. W. quoted above, should have wide boxes, large heating surfaces, piston valves, and whatever is found adding to their value—and the compound to have the same features so far as practicable.

It will be an interesting test when some road getting new power will decide to make it on strictly equal ground and terms —and when done, may we all be favored with a statement of result through the American Engineer.

Chicago, Ill. Geo. W. Cushing.

[Our correspondent directs our attention to a confusion of types of locomotives to which we must plead guilty, partially. The engine has twelve wheels. It is obvious that a proper classification of types is needed, and on page 374 of this issue will be found a suggestion on this subject.—Editors.]

A record of saving by the "Northwestern" type of 20 per cent. over other simple engines on the Chicago & Northwestern seems, in some quarters, to have led to the conclusion that there is no need for the compound locomotive if such improvements are being made in simple engines and we even hear of tests suggested between wide firebox simple engines and narrow firebox compounds, to learn which is better. An experienced physician once advised his students to make changes in treatment, one at a time, in order to be sure of knowing which medicine kills the patient. This seems rather suggestive in connection with the locomotive just now. A natural inference would be that if the compound is advantageous at all, it should be more so with other advantages, such as a wide firebox and a large boiler. That which improves the simple engine should be expected to also improve the compound, but perhaps not to exactly the same extent.

AJAX PLASTIC BRONZE.

The Ajax Metal Company, Philadelphia, are obtaining good results with their new bearing metal, which has been developed through their long experience and thorough study of the subject. This metal is an alloy of copper, tin and lead, combined through a patented process, whereby a relatively large proportion of lead is used without segregation. The difficulty has been to secure homogeneity with the desired proportion of lead, and this was some time ago accomplished successfully with this process, and the result is a metal which wears better than phosphor bronze because it has the all-important quality of plasticity.

Several years ago the Pennsylvania Railroad made exhaustive service tests with various combinations of copper, tin and lead, in order to determine the best composition which would be suitable for their service, and the conclusions drawn from the experiments were as follows:

1. The alloy of copper and tin shows 50 per cent. more wear than the standard phosphor bronze.
2. The phosphorus plays no part in preventing wear, excepting by producing sound castings.
3. Wear increases with the proportion of lead.
4. Wear diminishes with the diminution of tin.
5. Alloys containing more than 15 per cent. of lead, or less than 8 per cent. of tin, could not be produced because of segregation; but it was believed that if the lead could be still further increased and the tin decreased, and still have the resultant alloy homogeneous, a better metal in every respect would result.

The following table gives the results of these experiments:

Results of Pennsylvania Railroad Experiments.

Metal Tested.	Composition. Copper.	Tin.	Lead.	Phosphorus.	Arsenic.
Phosphor Bronze, standard..	79.70	10.00	9.60	.80	...
Ordinary bronze	87.50	12.50	....	...	...
Arsenic bronze, "A".........	89.20	10.00	....	...	.80
Arsenic bronze, "B".........	82.20	10.00	7.00	...	.80
Arsenic bronze, "C".........	79.70	10.00	9.50	...	.80
Bronze, "X"	77.00	8.00	15.00	...	...
	77.00	10.50	12.50	...	...

Relative Wear.

Phosphor Bronze, standard..	1.00	Arsenic bronze, "B"...........	1.15
Ordinary bronze	1.40	Arsenic bronze, "C"...........	1.01
Arsenic bronze, "A".........	1.42	Bronze, "K"	.92 .86

The predictions from the Pennsylvania experiments were confirmed by subsequent tests made by the Ajax Company on an Olsen friction machine in their own laboratory, and it was found that there is an almost constant relation between plasticity and wear. Their alloys showed less friction and ran at decidedly lower temperatures than those of the standard phosphor bronze. The results of these tests were as follows:

Tests on an Olsen Friction Machine.

	Friction (in lbs.).	Temperature (above temp. room).	Actual wear (in grains) 1,000,000 revolutions.	Compression at yield point (lbs. per sq. in.).
Phosphor Bronze	18½	50	10.5	31,700
Ajax Standard Engine....	18½	32½	7.2	19,550
Ajax 21 per cent. lead.....	16	44	6.7	19,100
Ajax 30 per cent. lead.....	16	40	3.06	17,210
Ajax 47 per cent. lead.....	13½	34	1.65	6,690

This process is carried out in all the alloys made by these manufacturers, and by doing so segregation is prevented in cases requiring much smaller proportions of lead than is used in the plastic bronze referred to. It has been noticed by users of Ajax metal that present results are better than were formerly obtained, and the company expects to improve them still more.

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We have received an account of a collision which occurred October 14 in the Anaconda yards of the Butte, Anaconda & Pacific Railway, which constitutes a demonstration of the value of the Westinghouse friction buffer. Incidentally it shows a surprisingly small amount of damage to the trains which were of pressed-steel cars, and on reading the account it is not to be wondered at that the end cars suffered somewhat. The result looks like a strong argument for good draft gear and steel cars, combined. The account is as follows:

Switch engine No. 3 was coupled to seven loaded pressed-steel ore cars at the east end of the yard, being on a side track. A man had been left to open the west switch, and, under the assumption that the track was clear, the engineer was given a signal to come ahead (west), pushing the cars. Twenty-nine similar cars (loaded) were at the other end of the siding,

about three-quarters of a mile from where the seven were coupled. As a result, a collision followed. No time for warning was given, and the seven cars and engine were moving at about thirteen miles per hour with the latter working steam. Under ordinary circumstances the air brakes would have been set on the twenty-nine care, and it is therefore assumed that such was a fact, though the number of cars showing evidence of having received a very severe shock gives rise to some doubt on this point.

The resultant injury to equipment consisted of the colliding ends of the two cars being considerably damaged, the worst being the seventh, or last, car from the engine. The damage to the other car was so much less as to enable it to be readily repaired by straightening the longitudinal sills and applying a new end sill. To facilitate this work (as repair material had to be ordered from Pittsburg), the end sill was removed from the car.

At the colliding ends, one coupler was broken in the shank, close to the head, and the other had the guard-arm broken off. The coupler was the "Standard," with solid knuckle. All of the cars were fitted with the Westinghouse friction draft gear, not one of which attachment, even on the colliding cars, was damaged in the least.

The opposite from the colliding ends of the two cars mentioned had slight kinks in the center sills, near the body bolster; the striking plate and end sill were bent in about 7/16 in., just back of the coupler head, and the coupler locking pin was wedged from the blow received through the knuckle of the opposite coupler. In 29 cars, 37 locking pins were so wedged. These were driven out, slightly ground, and returned to their couplers. About 20 cars had the center sills injured as described, but in no instance was the damage sufficient to require any repairs.

The average load of these ore cars is 110,000 lbs., their light weight is 34,800 lbs., and the engine, with tender, weighed about 150,000 lbs. For the engine and seven cars this makes a total of 1,163,600 lbs. At 13 miles per hour, and neglecting the effect of the steam being used, this represents a striking force of 6,575,000 foot-pounds, which is equivalent to the blow one of these 110,000-lb. capacity steel cars, fully loaded and weighing 72½ tons, would strike if dropped freely from a height of 54 ft. Even though no brakes were set on the 29 standing cars, their great weight and the small amount of slack between them insure that the enormous amount of energy in the engine and seven cars moving must have been dissipated in an exceedingly short distance.

That this was followed by such comparatively slight damage is a splendid tribute to the Westinghouse friction draft gear, to which Master Mechanic A. Harrity gives unbounded praise. While reducing greatly the consequent damage, it came out unscathed. Nor should the strength of the car or coupler pass unnoticed, though the weakest points in each, under buffing shocks, were demonstrated to be as described. **The coupler has a 6-in. shank, in this being out of the ordinary.**

TWO-CYLINDER COMPOUND CONSOLIDATION LOCOMOTIVE.

Minneapolis, St. Paul & Sault Ste. Marie Railway.

Heavy two-cylinder compound freight locomotives of the consolidation type have just been delivered to the "Soo" Line by the Schenectady Locomotive Works, and Mr. E. A. Williams, Mechanical Superintendent of the road, states that they have made their trial trips and are working very satisfactorily. We have received from him a photograph and some of the leading dimensions.

Two-Cylinder Compound Consolidation Locomotive, "Soo" Line.
E. A. WILLIAMS, MECHANICAL SUPERINTENDENT. SCHENECTADY LOCOMOTIVE WORKS, BUILDERS.

These engines are designed to haul 1,692 tons of train, exclusive of the weight of the engine and tender, up a 42-ft. grade 10 miles long, and to do this when working as compounds. The cylinders are 22½ and 35 by 30 in., the drivers are 55 in. and the boiler pressure is 210 lbs. The tractive power is 38,660 and the heating surface 2,549 sq. ft. A piston valve is used on the high pressure side, while the other has an Allen-Richardson balanced valve. Among the other details we note extended piston rods and brake shoes at the rear of the driving wheels. The design is attractive for such a large engine. The following partial list of the dimensions presents a good idea of the design:

Builders	Schenectady Locomotive Works
Type	Compound Consolidation
Cylinders	22½ ins. and 35 ins. diameter by 30 ins. stroke
Traction power	38,660 lbs.
Valves	H.-P. piston valve, L.-P. Allen-Richardson balanced
Driving wheels	55 ins. over tires
Weight on drivers	154,500 lbs.
Weight on truck	21,600 lbs.
Total weight, engine	176,100 lbs.
Weight of tender loaded	115,600 lbs.
Total weight of engine and tender	291,700 lbs.
Rigid wheel base	16 ft. 0 in.
Wheel base of engine	24 ft. 1 in.
Wheel base of engine and tender	53 ft. 9 in.
Boiler	Straight top, radial stays
Working steam pressure	210 lbs.
Diameter of boiler at arch	73½ in.
Firebox	length, 120 ins.; width, 41 ins.
Tubes, number	320
Tubes, diameter	2 ins.
Tubes, length	14 ft. 0 ins.
Heating surface, firebox	193 sq. ft.
Heating surface, tubes	2,356 sq. ft.
Heating surface, total	2,549 sq. ft.
Grate area	34.16 sq. ft.
Height from top of rail to top of stack	14 ft. 10 ins.
Height from top of rail to center of boiler	8 ft. 6 ins.
Capacity of tender, water	6,000 gals.
Capacity of tender, coal	10 tons

On the Maine Central a peculiar failure of air brakes was recently noted. An obstruction was discovered in the train pipe hose, and upon investigation a dead mouse was found. **The animal had crawled in through the coupling.**

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We have received an account of a collision which occurred October 14 in the Anaconda yards of the Butte, Anaconda & Pacific Railway, which constitutes a demonstration of the value of the Westinghouse friction buffer. Incidentally it shows a surprisingly small amount of damage to the trains which were of pressed-steel cars, and on reading the account it is not to be wondered at that the end cars suffered somewhat. The result looks like a strong argument for good draft gear and steel cars, combined. The account is as follows:

Switch engine No. 3 was coupled to seven loaded pressed-steel ore cars at the east end of the yard, being on a side track. A man had been left to open the west switch, and, under the assumption that the track was clear, the engineer was given a signal to come ahead (west), pushing the cars. Twenty-nine similar cars (loaded) were at the other end of the siding.

about three-quarters of a mile from where the seven were coupled. As a result, a collision followed. No time for warning was given, and the seven cars and engine were moving at about thirteen miles per hour with the latter working steam. Under ordinary circumstances the air brakes would have been set on the twenty-nine care, and it is therefore assumed that such was a fact, though the number of cars showing evidence of having received a very severe shock gives rise to some doubt on this point.

The resultant injury to equipment consisted of the colliding ends of the two cars being considerably damaged, the worst being the seventh, or last, car from the engine. The damage to the other car was so much less as to enable it to be readily repaired by straightening the longitudinal sills and applying a new end sill. To facilitate this work (as repair material had to be ordered from Pittsburg), the end sill was removed from the car.

At the colliding ends, one coupler was broken in the shank, close to the head, and the other had the guard-arm broken off. The coupler was the "Standard," with solid knuckle. All of the cars were fitted with the Westinghouse friction draft gear, not one of which attachment, even on the colliding cars, was damaged in the least.

The opposite from the colliding ends of the two cars mentioned had slight kinks in the center sills, near the body bolster; the striking plate and end sill were bent in about 7/16 in., just back of the coupler head, and the coupler locking pin was wedged from the blow received through the knuckle of the opposite coupler. In 29 cars, 37 locking pins were so wedged. These were driven out, slightly ground, and returned to their couplers. About 20 cars had the center sills injured as described, but in no instance was the damage sufficient to require any repairs.

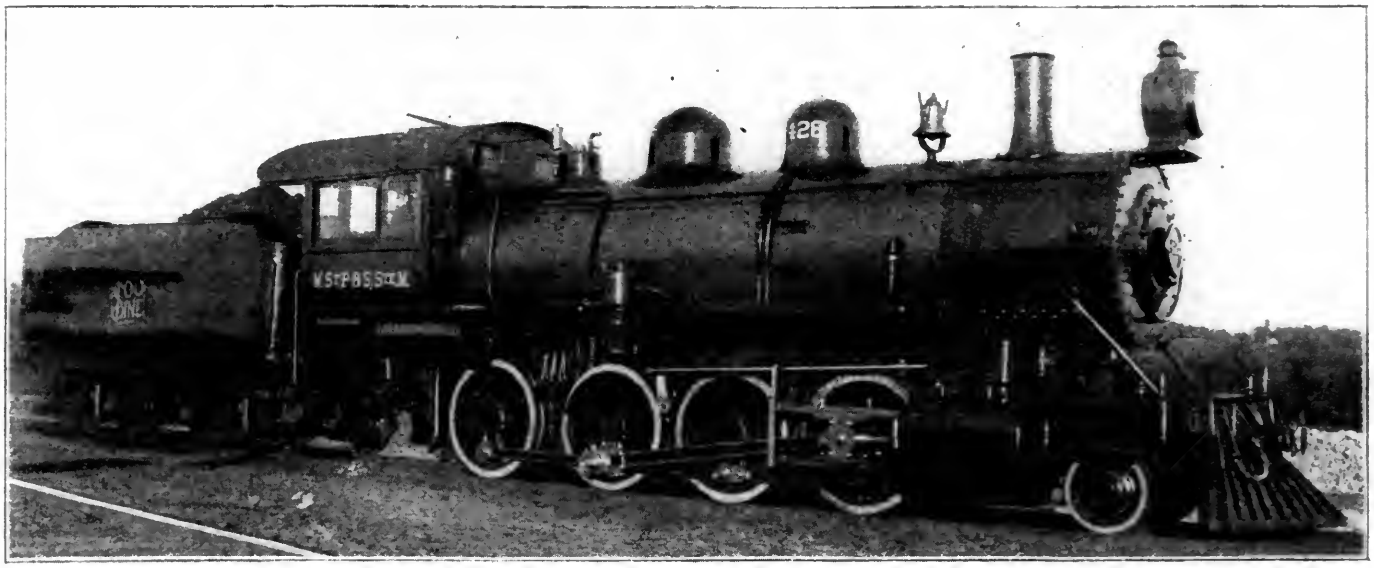
The average load of these ore cars is 110,000 lbs., their light weight is 34,800 lbs., and the engine, with tender, weighed about 150,000 lbs. For the engine and seven cars this makes a total of 1,163,600 lbs. At 13 miles per hour, and neglecting the effect of the steam being used, this represents a striking force of 6,575,000 foot-pounds, which is equivalent to the blow one of these 110,000-lb. capacity steel cars, fully loaded and weighing 72½ tons, would strike if dropped freely from a height of 54 ft. Even though no brakes were set on the 29 standing cars, their great weight and the small amount of slack between them insure that the enormous amount of energy in the engine and seven cars moving must have been dissipated in an exceedingly short distance.

That this was followed by such comparatively slight damage is a splendid tribute to the Westinghouse friction draft gear, to which Master Mechanic A. Harrity gives unbounded praise. While reducing greatly the consequent damage, it came out unscathed. Nor should the strength of the car or coupler pass unnoticed, though the weakest points in each, under buffing shocks, were demonstrated to be as described. The coupler has a 6-in. shank, in this being out of the ordinary.

TWO-CYLINDER COMPOUND CONSOLIDATION LOCOMOTIVE.

Minneapolis, St. Paul & Sault Ste. Marie Railway.

Heavy two-cylinder compound freight locomotives of the consolidation type have just been delivered to the "Soo" Line by the Schenectady Locomotive Works, and Mr. E. A. Williams, Mechanical Superintendent of the road, states that they have made their trial trips and are working very satisfactorily. We have received from him a photograph and some of the leading dimensions.



Two-Cylinder Compound Consolidation Locomotive, "Soo" Line.
E. A. WILLIAMS, MECHANICAL SUPERINTENDENT. SCHENECTADY LOCOMOTIVE WORKS, BUILDERS.

These engines are designed to haul 1,692 tons of train, exclusive of the weight of the engine and tender, up a 42-ft. grade 10 miles long, and to do this when working as compounds. The cylinders are 22½ and 35 by 30 in., the drivers are 55 in. and the boiler pressure is 210 lbs. The tractive power is 38,660 and the heating surface 2,549 sq. ft. A piston valve is used on the high pressure side, while the other has an Allen-Richardson balanced valve. Among the other details we note extended piston rods and brake shoes at the rear of the driving wheels. The design is attractive for such a large engine. The following partial list of the dimensions presents a good idea of the design:

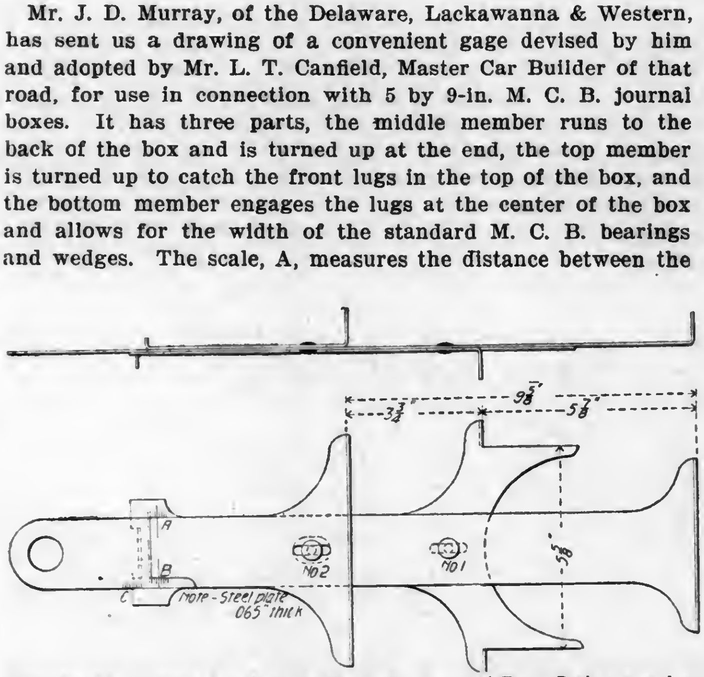
Builders	Schenectady Locomotive Works
Type	Compound Consolidation
Cylinders	22½ ins. and 35 ins. diameter by 30 ins. stroke
Traction power	38,660 lbs.
Valves	H.-P. piston valve, L.-P. Allen-Richardson balanced
Driving wheels	55 ins. over tires
Weight on drivers	154,500 lbs.
Weight on truck	21,600 lbs.
Total weight, engine	176,100 lbs.
Weight of tender loaded	115,600 lbs.
Total weight of engine and tender	291,700 lbs.
Rigid wheel base	16 ft. 0 in.
Wheel base of engine	24 ft. 1 in.
Wheel base of engine and tender	53 ft. 9 in.
Boiler	Straight top, radial stays
Working steam pressure	210 lbs.
Diameter of boiler at arch	73½ in.
Firebox	length, 120 ins.; width, 41 ins.
Tubes, number	320
Tubes, diameter	2 ins.
Tubes, length	14 ft. 0 ins.
Heating surface, firebox	193 sq. ft.
Heating surface, tubes	2,356 sq. ft.
Heating surface, total	2,549 sq. ft.
Grate area	34.16 sq. ft.
Height from top of rail to top of stack	14 ft. 10 ins.
Height from top of rail to center of boiler	8 ft. 6 ins.
Capacity of tender, water	6,000 gals.
Capacity of tender, coal	10 tons

On the Maine Central a peculiar failure of air brakes was recently noted. An obstruction was discovered in the train pipe hose, and upon investigation a dead mouse was found. The animal had crawled in through the coupling.

GAUGE FOR 5 BY 9 JOURNAL BOX.

Delaware, Lackawanna & Western Railroad.

Mr. J. D. Murray, of the Delaware, Lackawanna & Western, has sent us a drawing of a convenient gage devised by him and adopted by Mr. L. T. Canfield, Master Car Builder of that road, for use in connection with 5 by 9-in. M. C. B. journal boxes. It has three parts, the middle member runs to the back of the box and is turned up at the end, the top member is turned up to catch the front lugs in the top of the box, and the bottom member engages the lugs at the center of the box and allows for the width of the standard M. C. B. bearings and wedges. The scale, A, measures the distance between the



Convenient Gauge for 5 by 9 M. C. B. Journal Box—Delaware, Lackawanna & Western R.R.

front and center lugs, or the distance 3¾ ins. as indicated on the drawing. The scale B measures the distance from the front to the back of the box, or that indicated as 9⅝ ins. The scale C measures the distance between the center lugs and the back of the box, indicated as 5⅞ ins. The right-hand rivet holds the bottom to the middle part and the other rivet holds the top to the middle one.

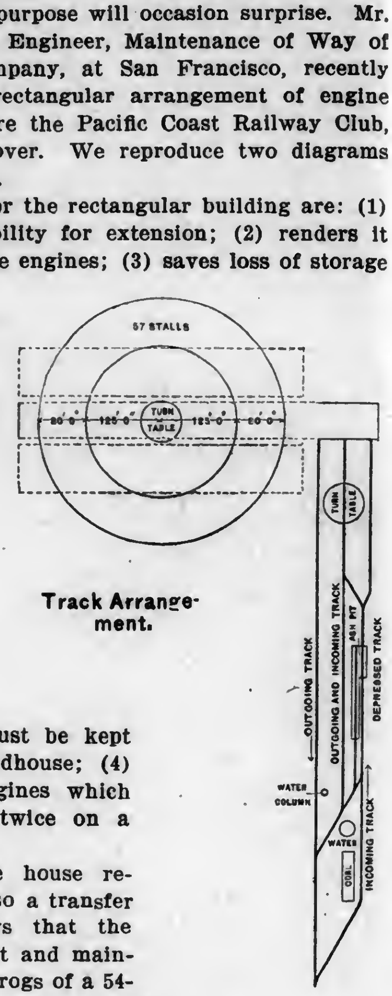
The gage may be used to measure old boxes in service when the bearing and wedge are removed, and it is also useful in measuring boxes in the inspection of cars at the works of the builders. For the latter purpose it is found to be more convenient to reverse the arrangement of the scales and measure the boxes when turned upside down. For a gage to measure the width between the lugs Mr. Murray uses a separate piece of the same shape as the bottom member of the combination gage, but shorter. It is illustrated in the sketch. These gages were devised from a suggestion received from Mr. Whyte's article on page 273 of our September number, in which the 5 by 9 journal box was criticised.

The comments upon brass furnaces in general and upon the furnace designed by Robert Wagner, of Germany, in our November number, were made with the idea that the customary brass foundry methods are very crude and that improvements, particularly in the melting furnaces, would result in considerable saving. The comments were made in ignorance of the fact that the particular furnace referred to is controlled and manufactured in the United States by the Ajax Metal Company of Philadelphia. This furnace has been used by this company for seven years with excellent results. In fact it is believed that there is no better furnace known at present for the smelting of brass. It has stood the test of experience and the fact that the Ajax people use it in their commercial practice and that they thought so well of it as to secure the exclusive ownership of the rights in this country, is enough to say of it as a practical success. We illustrated the furnace because it attracted our attention as an important improvement and it is pleasant to learn that our opinion of it has such substantial and unqualified indorsement.

ROUND VS. RECTANGULAR "ROUNDHOUSES."

The locomotive "roundhouse" has by universal consent become the building used for the temporary housing of locomotives in this country until the mere suggestion of any other form of building for this purpose will occasion surprise. Mr. John D. Isaacs, Assistant Engineer, Maintenance of Way of the Southern Pacific Company, at San Francisco, recently offered a scheme for a rectangular arrangement of engine house for discussion before the Pacific Coast Railway Club, which is worth looking over. We reproduce two diagrams illustrating his suggestion.

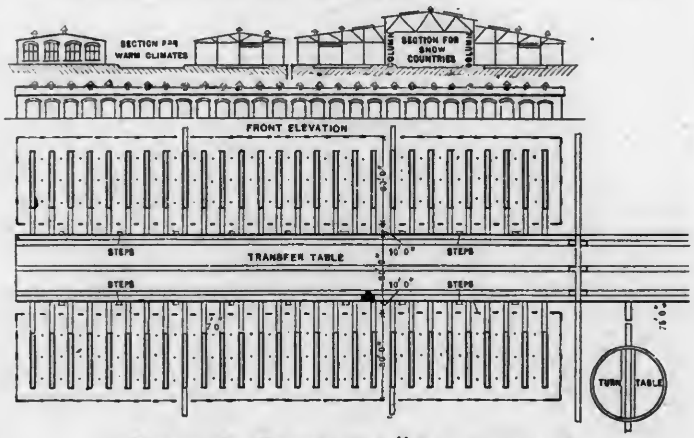
The advantages urged for the rectangular building are: (1) It provides for the possibility for extension; (2) renders it easy to use cranes over the engines; (3) saves loss of storage



Track Arrangement.

room for stalls which must be kept free for access to a roundhouse; (4) saves one turning of engines which must always be turned twice on a roundhouse turn-table.

The rectangular engine house requires a turn-table and also a transfer table, but Mr. Isaacs says that the transfer table can be built and maintained for the cost of the frogs of a 54-



Scheme for Rectangular "Roundhouses."

stall roundhouse. He believes the time required for handling engines would be about equal in both plans, and as to the land occupied by the two classes of buildings, he makes the following comparison:

A circular engine house with, say, 57 stalls would occupy a neat area of 3.02 acres. Assuming that three of these stalls would be kept unoccupied for access to so large a building, the actual capacity would be 54 engines. A rectangular engine house with 54 stalls would occupy a neat area of 2.6 acres, or about 16 per cent. less area than the circular building. But the roundhouse may be considered as occupying a square of ground the sides of which are the diameters of the circle. To offset this there should be added, say, 110 ft. to the length

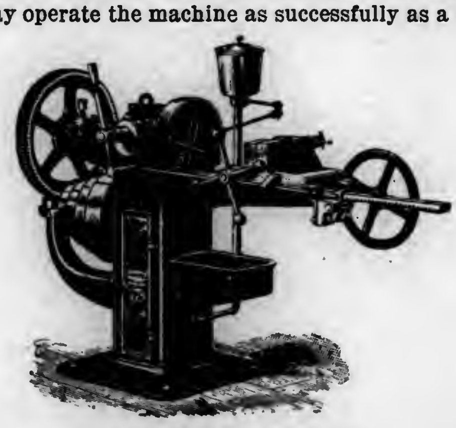
of the rectangular house for the extra length required for the transfer pit outside of the building, and the areas then become: Rectangular building, 2.74 acres; circular building, 3.86 acres; or about 40 per cent. more for the roundhouse.

The actual space occupied by the engine house, however, is seldom as important as the shape of the ground space, and the facilities for getting a good track arrangement and good location for the coal chute, water crane, sand house and ash pit. Mr. Isaac's suggestion is presented here for two reasons. It is a plan which may work out better than the roundhouse in certain difficult cases and it may prove to stimulate thought upon the question of terminal facilities for handling locomotives which is becoming more important with every increase in congestion of traffic.

THE SCHLENKER BOLT CUTTER.

Howard Iron Works, Buffalo, N. Y.

This machine uses dies similar in action to a lathe tool, leaving a clean and perfect thread with one passage over the bolt, and when the required length of thread has been cut the dies open automatically. The dies are simple in form, which reduces their first cost below that of many forms, and when dull they may be ground like a lathe tool and re-cut many times before they are worn out. Their attachment or detachment may be effected instantly, without removing a screw, pin or bolt. The machine will cut either right or left handed, square, V-shaped or coach threads, and a specially strong claim is made for accuracy. The design was guided by a desire to render the operation so simple that any intelligent boy who can read figures may operate the machine as successfully as a high-priced



The Schlenker Bolt Cutter.

mechanic. The gears and pinions are cut, the wearing parts are of steel and carefully fitted, the bearings are large and are provided with adjustments to take up wear. The machines will tap nuts as well as thread bolts and will take crooked work as well as straight. They are made in a number of sizes and capacities from ¼ in. to 3 ins. in diameter. Our engraving illustrates their general features and gives the impression of convenience, strength and compact form. The manufacturers are the Howard Iron Works, Buffalo, N. Y., who also manufacture pulleys, hangers, shafting, vises, pulleys, clutches and special machinery.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The forty-second meeting of this society will be held in the rooms at 12 West 31st Street, New York, December 4 to 7, with the following programme of professional papers:

Parsons, H. de B.: "Comparison of Rules for Calculating the Strength of Steam Boilers."

Porter, Chas. T.: "A Record of the Early Period of High Speed Engineering."

Thurston, Robt. H.: "Steam Engine of Maximum Simplicity and of Highest Thermal Efficiency."

Sangster, Wm.: "Note on Centrifugal Fans for Cupolas and Forges."

Dean, F. W.: "Power Plant of the Massachusetts General Hospital."

Bolton, Reginald P.: "The Construction of Contracts."

Adams, E. T.: "An American Central Valve Engine."

Wickhorst, Max H.: "Mechanical Integrator Used in Connection with a Spring Dynamometer."

Read, Carleton A.: "Apparatus for Dynamically Testing Steam Engine Indicators."

Goss, W. F. M.: "Tests of the Boilers of the Purdue Locomotive."

Bristol, W. H.: "A New Recording Air Pyrometer."

Wheeler, F. Merriam: "Comparative Value of Different Arrangements of Suction Air Chambers on Pumps."

Gregory, W. B.: "Tests of Centrifugal Pumps."

Keep, Wm. J.: "Hardness, or the Workability of Metals."

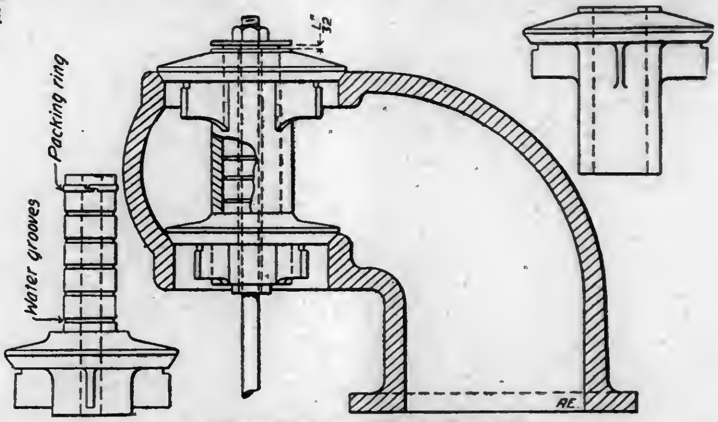
Sargent, Chas. E.: "New Principle of Gas Engine Design."

Kerr, C. V.: "Heat Efficiency of the Gas Engine as Modified by Point of Ignition."

Jones, Forrest R.: "Power and Light for the Machine Shop and Foundry."

CHAMBERS' COMPENSATING THROTTLE VALVES.

A new throttle valve by Mr. John S. Chambers, Master Mechanic of the Central Railroad of New Jersey, at Elizabethport, N. J., has been adopted as standard on that road by Mr. McIntosh. It is designed to provide for automatic adjustment of the disks of the throttle to provide for differences in the expansion of the throttle casing and the valve itself. With the usual construction, and the valve made in one piece, considerable difficulty is found in keeping the valves tight. To overcome this Mr. Chambers makes his valve in two parts, shown in the detail views. The upper disk has a sleeve which surrounds a corresponding sleeve on the lower disk. The spindle



Chambers Improved Throttle.

passes through both and under the washer at the top; a space of 1/32 in. is provided for automatic adjustment of the distance between the disks. The inner sleeve has water grooves and it may also have a packing ring at the top to guard against leakage of steam between the sleeves.

The valve is ground to the seats as usual, and when the expansion and contraction of the valve and the casing are the same the valve acts like an ordinary throttle, but if the casing expands more than the valve the automatic adjustment takes care of the difference, which must at all times be very small, and experience shows that the valve remains tight. Mr. Chambers expects these valves to remain tight between the periods of general repairs to the engines. As it costs about $8 to grind a leaking throttle, a considerable saving is expected.

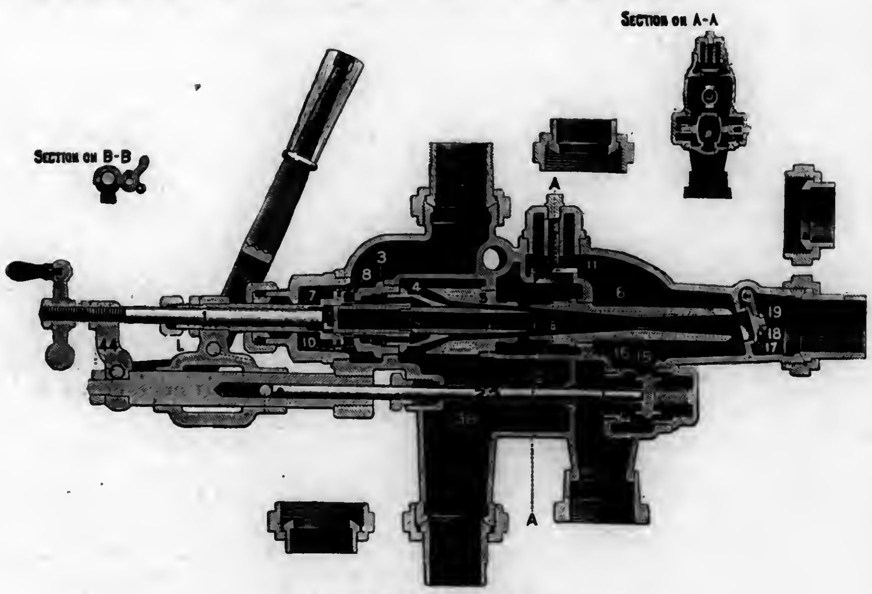
Careful examination of the drawing may lead to the question of the tightness of the lower disk against its seat when the casing expands more than the valve, because the steam pressure upon the lower disk must tend to raise it until stopped by the lower end of the sleeve of the upper disk. As stated, there seems to be no leakage, and this probably means that the amount of difference in expansion is very small, probably not more than the thickness of a film of water between the two disks. When the throttle is operated the two disks seem to move together as in the usual construction. The improvement has been patented by Mr. Chambers.

THE LUNKENHEIMER "99 MODEL" INJECTOR.

The "99 Model" Lunkenheimer standard locomotive injector has been redesigned with a view of meeting the severe requirements of a service involving a wide range of loads and temperatures. It can be started promptly, under most conditions, at all pressures from 30 to 250 lbs., and is not sensitive, there being no fear of uncertainty of action. It works without adjustment of the steam or water at pressures between 40 and 250 lbs., and the capacity may be reduced over 50 per cent. at all points. In this model, when the water discharge is reduced the steam consumption is also reduced in direct proportion, instead of the water supply being alone cut down. This is the basis for a claim for economy superior to that of other makes. Durability was prominently in mind in its development. The overflow valve is held positively to its seat when working and all of the water is forced into the boiler. The lifting and forcing tubes are combined in one line, the only tube subject to appreciable wear being the forcing combining tube, which is made large and is free from spill holes.

It may be easily renewed and at slight expense when necessary. All of the tubes are screwed in from the same direction and all may be removed or replaced without dismantling or disconnecting the injector more than to remove the steam valve bonnet. The valves are also conveniently placed and accessible and the body casting is in a single piece. The line check valve is of the swing pattern which gives a full waterway and when worn in the seat it may be reground without removal from the body of the injector.

The starting is by a single movement of the starting lever; the first portion effects the lifting and the further movement puts it into full operation. To regulate the discharge the crank handle is used, and it will change the capacity from maximum



Lunkenheimer Injector.

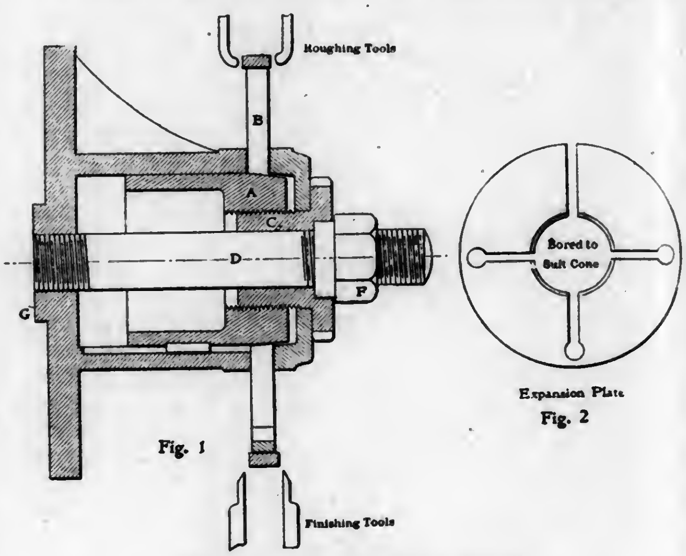
to minimum at all pressures between 40 and 250 lbs. It is necessary to manipulate the crank handle only at pressures below 70 lbs.; above that pressure the injector is started without reference to the delivery and the water is regulated afterward without danger of breaking the stream. On short lifts the water may be as hot as 135 deg. F. at all pressures up to 250 lbs. A convenient and simple heater attachment is provided. All injectors are tested before shipment to pressures up to the limit stated and with water at 76 deg. F., with a lift of 5 ft. They are also tested for working hot water.

The manufacturers, the Lunkenheimer Company, Cincinnati, O., have had remarkably successful results with this model. This is the only injector on the market which cuts down the steam consumption in direct proportion to the amount of water discharged.

MANDREL FOR FACING PISTON RINGS.

The accompanying engraving illustrates an expansion mandrel for use in facing piston rings on both sides at one operation and was described by Mr. G. R. Martin, of Thames Ditton, in a recent issue of the "American Machinist." We have seen many schemes devised for doing this work, but none quite so effective and convenient as this.

The features of this device are the expansion disk marked



Mandrel for Facing Piston Rings.

B in Fig. 1, around which is placed the ring to be faced, and the mechanism used to effect this expansion. A front view of the disk is shown in Fig. 2. The main body casting, which is presented in section in the drawing, is screwed to the face plate of the lathe, the projecting part, G, fitting into the hole in the face plate and serving as a guide in setting the mandrel. Cylinder A slides freely inside of the main casting, but is feathered to prevent it from turning. One end of this cylinder is cone-shaped, the taper corresponding with that of the expansion plate. A sleeve, C, fits loosely over the stud bolt, D, and screws into the cone and is held in position by the nut, F.

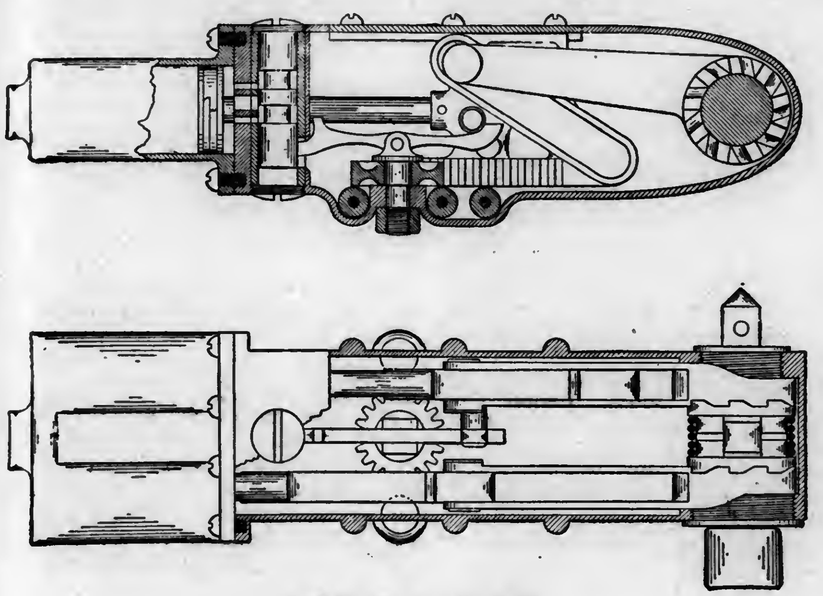
To go through the operation, the ring is placed around the expansion disk, the sleeve, C, screwed sufficiently tight with the fingers to hold the ring, while it is set true by running the lathe and holding the blunt end of the tool to the face of the work. The sleeve and nut, F, are then further tightened to hold the ring firmly.

The frankness with which American machinery builders and manufacturers usually show their products and open their works to visitors calls out frequent comment from foreign engineers which serves to bring out the contrast between different nationalities in this respect. We are not losers by showing others what we have, for in the very act of showing we may acquire a suggestion of improvement and a thing guarded and maintained secretly cannot grow as it would in the open air. Furthermore, one who is large-minded enough to show his ways to others is likely to be shrewd enough to learn from others.

U. & W. PISTON DRILL.

The drill shown in the accompanying engraving is that of the U. & W. Piston Air Drill, manufactured by the Columbus Pneumatic Tool Company of Columbus, Ohio. It is of an entirely different design from other machines of this class, and embodies some novel and practical ideas.

This machine is of the double-piston type, both pistons working through the medium of arms and cross-heads upon a single shaft, turning it with the power derived from both cylinders. In order to effect this concentration of power a gear is placed between the cross-heads, working in racks cut at the base of each. The successive strokes of the cross-heads move the ends of the arms up and down. The other ends of these arms encircle the shaft and have teeth interlocking those in clutches, which, in turn, move along the shaft and engage lugs on it, thus revolving the shaft. The teeth of the arms and clutches never engage except on the forward stroke, or at the time of the upward movement of the end of the arm. As air enters the cylinders at the end of each stroke, it will be seen that the gear referred to above is of great importance, inasmuch as it is the medium of transmission of the power developed in the return stroke to the side on the forward or working stroke.



U. & W. Piston Air Drill.

Two valves and a shifter distribute the air. The auxiliary valve is set by the shifter in its movement up and down, and the main valve is set by air properly admitted by the auxiliary.

The points of superiority claimed for this tool are durability, capacity for doing work in close quarters, strength, lightness, and the absence of the necessity of frequent oiling.

It was once said by a Scotch university professor to a rather stupid student, "Mon (he spoke in his native Scotch), I can teach ye Latin and I can teach ye Greek, but common sense is beyond my power tae gi' ye; if ye ha'e na that ye air to be pitied."

In describing the interesting water scoop for tenders on the Lake Shore & Michigan Southern, on page 345 of our November issue, we stated that the castings were of malleable iron. This is misleading, as a glance at the drawings will at once show. The drawings were made for cast iron parts, and we should have stated this fact, and also that malleable iron was considered for future practice. This opportunity is taken to point again to the feature of this design whereby machine work on the jointed sections is avoided.

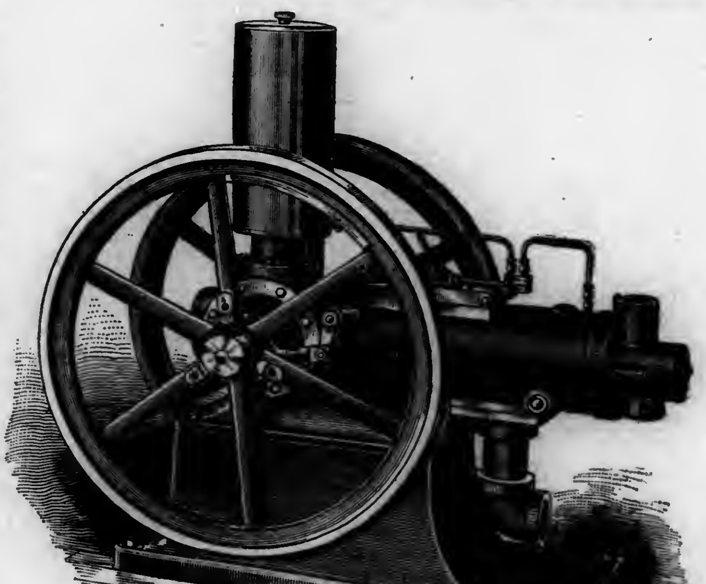
MIETZ & WEISS KEROSENE ENGINE.

The fact that kerosene is available everywhere at a low cost and has the necessary qualities of a good fuel with the highest thermodynamic value, has opened a large field of usefulness for the kerosene engine in isolated electric lighting plants and railroad pumping stations.

Its ease of management, economy, and safety recommend it as a very desirable motor in places where the steam engine is inconvenient for many reasons. It is true that in the modern steam engine as a power transmitting machine the chances for real improvement are very limited, but summing up all its necessaries as a prime mover, starting at the coal mine, or even at the coal yard, we have an entirely different situation. The four-cycle single cylinder gas engine, receiving, as it does at its best, only one power impulse for every two revolutions of its shaft, is not the ideal electric light engine.

The engine shown is of the two-cycle compression type, receiving a power impulse every revolution and provided with a sensitive governor maintaining the steady speed required for belted or direct coupled generators. A small pump operated and controlled by the governor injects the precise amount of kerosene (ordinary lamp oil) directly in the motor cylinder, where it vaporizes and mixes with air for combustion.

The oil reservoir is placed at the side of the engine frame and at a certain point in each revolution a partial vacuum is created in the crank chamber and in the cylinder. This is sufficient to draw the necessary oil from the pipes and down past the sight holes which permit its proper regulation by the valves above. The oil for the crank drops into a groove on the top of the rod, whence it finds its way to the pin. The automatic oiling devices, it will be noted, are only operative when the engine is running, and when the engine is stopped they require no attention. When the engine is to be stopped it is only necessary to throw up the little finger which regulates the oil supply.



Mietz & Weiss Kerosene Engine.

Catalogues and blue prints of this engine can be had by applying to August Mietz, 128-138 Mott street, New York.

BOOKS AND PAMPHLETS.

Machine Tools.—The Hilles & Jones Company, Wilmington, Del., have just issued a tasteful catalogue of machine tools for working plates, bars and structural shapes. Among the tools of large capacity illustrated are single and double punches and shears, coping and notching machines for I-bars, channels and angles, railroad fish-plate punches and fish-plate notchers; also bending and straightening machines. The engravings are excellent half-tones and the work throughout is of high character.

Westinghouse Railway Motors.—A pamphlet of 44 pages illustrating and describing the Westinghouse standard types of railway motors has just been received. It presents a number of different designs which have been evolved in the 10 years' experience of the Westinghouse concern, to meet various conditions of service and equipment. Special attention has been given to the construction of the motors to avoid a difference of temperature rise in the field and armature windings and the ventilated armature is carried to a high development. The pamphlet also contains illustrations of a few typical power stations.

Bolt Threading Machinery.—Based upon the extensive and varied experience which the Webster & Perks Tool Company, of Springfield, Ohio, have had with all kinds of screws and bolts and many different makes of machines for manufacturing bolts, they are offering a line of solid die, automatic threading machines which are very effective and simple in construction. Their new catalogue on bolt threading machinery which has just been received illustrates and briefly describes their two spindle, rapid, direct, belted and one, two, four and six geared solid die automatic threading machines. This concern also manufactures grinding and polishing machinery, which is described and illustrated in a special pamphlet. This class of machinery is growing constantly in importance.

Pneumatic Tools.—The Chicago Pneumatic Tool Company has issued a new catalogue which is their Exposition Edition with a supplement. The exhibits of this company at Paris were very extensive and were composed of three separate exhibits. Their pneumatic tools and appliances, which were shown in direct application to practical work, in so far as possible, covered all branches of industry. Among the many new and interesting appliances pictured in this book are pneumatic flue welders, reducers and expanders, car and locomotive jacks, cranes mounted on hand trucks for loading axles, timbers and car trucks, improved oil-rivet heaters and mud-ring riveters, and, of course, pneumatic hammers. The illustrations are excellent and the very brief descriptive matter accompanying the engravings is in English, French and German.

Proceedings of the Rocky Mountain Railway Club, Denver, Colorado, October, 1900.—This organization has in a very short time, about six months, been organized and brought to a state of efficiency which will place it among the successful and important railway clubs which are doing so much for the improvement of our railroads. The first copy of the proceedings to reach us contains discussions upon the subjects of "Brown's Discipline" and the delays to trains. Both are important and they indicate a broad view of the possibilities of such an organization on the part of the officers. We are in hearty sympathy with efforts to improve railroad practice through clubs of this kind.

Steel Rails and Fastenings, Vol. II., 1900.—The Cambria Steel Company, Philadelphia, have just issued a book entitled "Steel T-Rails and Fastenings." This volume, which is number two, shows sections of T-rails and their joints, T-rail guards and frog fillers; also gives in the form of tables, useful information regarding the materials used for track construction, such as the number of tons of rails required per mile, of various weights per yard, number of spikes, cross ties, splice bars and bolts per mile of track, and the number of joint fastenings to the ton of rails. The book also contains an extensive list of the different railways and the weight and section number of the rails used by each. The list shows that most of the roads have adopted as standard the "American Society of Civil Engineers" sections, to which about 75 per cent. of all rails made last year by American mills were rolled.

The contents of the December Magazine Number of The Outlook are varied. Among the special articles will be found the fifth installment of the autobiography of Booker T. Washington, called, "Up From Slavery;" the final installment of Mr. Hamilton W. Mabie's "William Shakespeare: Poet, Dramatist and Man," which has now been published by the Macmillans in sumptuous book form; elaborate articles reviewing the ablest books of the season in the departments of art, biography and fiction, with many portrait illustrations; and, most prominent of all, a series of brief articles by such men as James Bryce, Henry van Dyke, Edward Everett Hale, President Hadley, of Yale, and half a dozen others, giving their opinions in reply to the question "What Are the Greatest Books of the Century?" The Outlook Company, 287 Fourth Avenue, New York.

Proceedings of The Master Car Builders' Association, Thirty-fourth Annual Convention, Held at Saratoga, June, 1900. Edited by the Secretary, Mr. J. W. Taylor, 667 Rookery, Chicago, Ill.

This volume is uniform with those of the proceedings of this association for several years, and it appears with the customary promptness which the Secretary has taught us to expect. It contains the official record of the proceedings of the recent convention, the constitution and lists of officers and members and a complete set of the drawings of the standards and recommended practice of the association. These are put in most convenient form for reference. Our readers are familiar with the work of this association and know the value of the records. The subjects for next year, which we printed last month, promise an unusually interesting convention next summer, with specially inportant discussions.

Air Brake Catechism. A Complete Study of the Air Brake Equipment, Including the Latest Devices and Inventions Used. All Troubles and Peculiarities of the Air Brake and Practical Ways to Remedy Them. By Robert H. Blackall, Air Brake Instructor and Inspector, Westinghouse Air Brake Company. Illustrated. Published by Norman W. Henley & Co., 132 Nassau street, New York. Price, $1.50.

This is the most satisfactory book upon the air brake. It is written by a practical expert who is familiar not only with the subject, but with methods of explaining it, and it is both convenient in form and moderate in price. It is not strange that it has gone through twelve editions. We have printed notices of previous editions and can add at this time that the work is kept strictly up to date. It is well adapted to the use of students and to men who use and maintain the air brake because of its clear and concise treatment of the entire subject. The engravings are clear enough, but with the exception of the folding plates they do not call for especially favorable comment. To one who desires to know how the air brake operates and how to maintain it or use it this book will be invaluable.

Freehand Perspective: For use in Manual Training Schools and Colleges. By Victor T. Wilson, Instructor at Cornell University. Published by John Wiley & Sons, New York, 1900. First Edition, 268 pages; illustrated. Price, $2.50.

Those who have had instructional work in the crafts, whether as teacher in a technical school or as director of workmen in a shop, have felt the need of the ability to use the methods presented by Mr. V. T. Wilson in his treatise on Freehand Perspective. While one might wish that the subject could be presented in a more concise form, in looking through the book he has difficulty in selecting a place where he would wish to prune. The arrangement is consecutive, and the illustrations are sufficiently numerous, even for this subject, and are well chosen. Familiarity with the methods developed by the author would be undoubtedly of great value to the mechanical draughtsman, as the necessity for the perspective sketch,

either to elucidate a mechanical drawing or as a memorandum, is of constant recurrence. The treatment of the mathematical side of the subject develops all that is necessary of it in a simple manner, and the illustrative sketches are happily selected and well executed.

Exhausters, Heaters and Engines.—The New York Blower Company, 39-41 Cortlandt street, New York, has just issued a very neat catalogue, illustrating and briefly describing their exhausters, sectional heaters and engines. This, their first catalogue, does not give a complete line of the products manufactured by them, but is issued as a sort of introduction to the trade. Besides steel plate exhausters for exhausting air, smoke, gases or material of a granular, pulpy or fibrous character, they are building a complete line of heaters, blowers and engines, together with ventilating, drying and mechanical draft apparatus and appliances. These are built upon the most approved and advanced lines. The exhausters, with the exception of cast-iron bed plates, inlet and outlet rings and the heavy pedestals which support the running parts, are made throughout of steel plate, re-enforced by substantial wrought angle iron frames. This construction enables these machines to sustain without injury the sudden strains caused by knots, blocks, etc., passing through, which would quickly wreck the ordinary cast iron exhauster. A noteworthy feature of the catalogue is its clear line engravings with lettered dimensions and accompanying tables giving in inches the values of the indicated letters for a large number of sizes of exhausters. The catalogue should be in the hands of all users of this class of machines.

"Atlantic Type Locomotives" is the title of pamphlet No. 20 in the series entitled "Record of Recent Construction," issued by the Baldwin Locomotive Works. This pamphlet surpasses in attractiveness all previous ones in this interesting series. This number is devoted to the "Atlantic Type" and it contains descriptions and records of a large number of engines by these builders, several of which have become world famous, for example, those hauling the Atlantic City Flyer of the Philadelphia & Reading. The reason for the introduction of this type is stated in a quotation from the article by Mr. Edward Grafstrom, now Mechanical Engineer of the Atchison, Topeka & Santa Fe, in the American Engineer and Railroad Journal of May, 1900, which may be summed up as follows: This type permits of securing large steam making capacity without involving the use of six coupled wheels. The pamphlet contains excellent half-tone engravings of the locomotives, accompanied by perspective diagrams giving the leading dimensions and wheel base. Most valuable letters from motive power and operating officers are included and they present the facts of experience in mileage and performance. These are in both French and English. The publication is wholly admirable and worthy.

Baldwin Locomotive Works.—Illustrated Catalogue of Narrow-Gauge Locomotives. Especially Adapted to Gauges of 3 ft. 6 in. or 1 Meter. This is a revised edition of the earlier catalogue of narrow-gauge locomotives by these builders. The book, which has 452 pages, opens with an elaborate history of the Baldwin Locomotive Works, in which their development to the present enormous establishment is traced. This is followed by general specifications of locomotives, physical tests of material and class designations. A number of tables of dimensions of locomotives, accompanied by full-page half-tone engravings, introduce the subject of the Vauclain system of compounding, which is described in detail with engravings of the essential parts. The latter half of the work contains instructions for cabling; also a series of diagrams of various types of locomotives. An elaborate series of illustrated plates with the parts numbered is included for the aid of those who desire to order parts for repairs. The book will be very useful to those who desire to investigate the Vauclain system to order locomotives of these types, and especially to those who already have them in service and who have occasion to order repair parts. It is bound in cloth and is provided with an excellent index.

Messrs. Manning, Maxwell & Moore, New York, have just issued a 700-page illustrated imperial quarto catalogue of Machine Tools and Their Attachments. It illustrates only metal and wood working machinery and their accessories. Owing to the greatly increased scope of their business this firm finds it advisable to separate these tools from what are termed "general supplies," which were all combined in previous catalogues. This leads to the compilation, now under way, of complete illustrated catalogues of railway, steamship, machinists' and contractors' tools and supplies, which will contain over 800 pages of the size of the present volume. The catalogues of this firm cover so wide a field that one of them is a compendium of the present state of the art in its line. In this volume, as in previous ones, each illustration has a figure number for the purpose of ordering from the catalogue. The figure numbers are intended to be used in preference to the names of the tools. The catalogue is also provided with a code by which telegraphic and cable communications may be greatly condensed. For customers who find it more convenient to communicate with branch offices, attention is called to the fact that they have a large store in Chicago, in charge of Mr. A. J. Babcock as manager, at 22, 24 and 26 South Canal Street, where there is carried a full and complete stock of the latest improved machine tools, ready for quick delivery; a large office in Pittsburg, at 1005 Park building, in charge of Mr. Robert A. Bole, and in Cleveland an office at 1620 Williamson building, in charge of Mr. F. B. Ward. In New York there are three large warehouses, outside of the commodious store, filled with machinery for prompt delivery. It is impossible to present an idea of the catalogue under review better than to say that the wants of those requiring machinery of this general character will be found to be anticipated in its pages. It is a valuable book and represents a very large amount of labor. It has every appearance of having been carefuly compiled. Each machine is concisely described and the chief dimensions and figures of capacity are included.

EQUIPMENT AND MANUFACTURING NOTES.

The Richmond Locomotive Works have received orders for six locomotive boilers from the Central Vermont Railway, and for one locomotive boiler from the Cincinnati Northern Railway.

The Boston Belting Company, 256 Devonshire Street, Boston, are distributing advertising blotters which are acceptable everywhere because they are really good ones and will absorb ink on either side. A set of them will be sent upon application.

The Missouri Pacific Railway Company has placed an order with the American Car & Foundry Company for 500 low-floor furniture cars, which are to be equipped with the Shickle, Harrison & Howard Iron Company's cast steel trucks and bolsters.

The Boston & Maine Railroad and its connections lead direct to the great game regions of Maine and New Hampshire, and the publication which is issued by the Boston & Maine Passenger Department, Boston, known as "Fishing and Hunting," describes how and where to shoot. Send for it; the cost is but a two-cent stamp.

It is stated that the preferred stockholders of the Pratt & Whitney Company, which has been absorbed by the Niles-Bement-Pond Company, will receive 70 per cent. in new preferred stock and 30 per cent. in common. The Niles-Bement-Pond Company has declared a regular dividend of 1½ per cent. on its preferred stock.

The business of the New York Blower Company, heating and ventilating engineers, has developed to such a point as to necessitate opening a branch office in Chicago, which they have done in the Merchants' Loan & Trust Building. This company now has offices in New York, Boston and Chicago, in addition to the home office in Bucyrus, O.

The National Car Coupler Company, of Chicago, has opened an office at 150 Broadway, New York, and will be represented

by Mr. S. A. Stevenson. This is found necessary on account of the increased volume of business in the Hinson coupler, the National steel platform and buffer and the Hinson draw-bar attachment. Mr. Stevenson has had a long railroad experience on the Wabash and other roads, and has a wide acquaintance among railroad men.

The Richmond Locomotive Works have just received an order from the Rio Grande Western Railway for five 23½ and 30 by 28-in. compound consolidation locomotives, the principal dimensions of which are as follows: Drivers, 56 ins. in diameter; total weight, 187,000 lbs.; weight on drivers, 170,000 lbs.; firebox, 122 by 41 ins.; total wheel base, 24 ft. 6 ins.; driving wheel base, 16 ft. 3 ins.; tires, 3½ ft. thick; driving axle journals, 9 by 12 ins.; steam pressume, 185,000 lbs. The tenders will carry 6,000 gallons of water.

The Westinghouse Air Brake Company have received orders for their friction draft gear from the Baltimore & Ohio Railroad for 7,500 new cars, 6,000 of which are now being built by the Pressed Steel Car Company, the other 1,500 being wooden cars ordered from the Pullman Company. They have also received orders for the draft-gear for 5,000 cars for the Pennsylvania Railroad. Orders for 12,500 sets or 25,000 single gears from such roads as these constitute a strong endorsement which requires no comment.

Mr. Jos. H. Williamson, who for nearly eighteen years has been the business manager of the Manufacturers Advertising Agency, New York City, announces that he has severed his relationship with that company to connect himself with the well-known Viennot Advertising Agency, 524 Walnut street, Philadelphia, as its business manager in the place of Mr. Thompson, resigned. Mr. Williamson will be glad to welcome his friends at the office in Philadelphia, or at the New York office of the Viennot Advertising Agency, 127 Duane street, Graham Building.

To those who are considering the purchase of machinery or any system of mechanical appliances the Philadelphia Bourse offers unusual opportunities in its exhibition department, where facilities are provided for practical demonstrations of the work of machinery in operation. The Bourse, through its exhibition department, is an important machinery trade center and is kept in close touch with progress through inquiries for all classes of machinery. On account of these inquiries for the builders of various classes of machinery, prices, etc., a bureau has been established where such information may at all times be had. The bureau has a free local telephone for the use of exhibitors and in the event of the absence of the exhibitor or his representative messages will be carefully attended to and considered confidential. Thus the Bourse is filling a long-felt want and is doing it in a way which is sure to be appreciated.

Mr. James L. Taylor has been elected Third Vice-President of the Consolidated Railway, Electric Lighting & Equipment Company. He was until recently the General European Agent of the Pennsylvania Railroad in London, and previously had a railroad experience in this country, having served in prominent positions on the lines forming the Plant and Southern Railway Systems, before entering the service of the Pennsylvania. He is well and favorably known in this country as a railroad man, and during his residence abroad attained an enviable position in the social and railway world. He was president of the American Society in London and delegate to the International Railway Congresses in London and Paris. He was connected with the American Commissions at both the Brussels and Paris Expositions, and for his services at the first named he has the decoration of the Order of Leopold. Mr. Taylor's election promises to be a valuable addition to the organization of the Consolidated Company.

The American School of Correspondence, Boston, being situated in a large city which is a recognized educational and industrial center, has many natural advantages in teaching the theory of the trades and engineering professions. Without leaving home or losing time from work, the student pursues a thorough course of study under the direction of able instructors, who are always ready and willing to assist him. Instruction papers, prepared especially for teaching by mail, are furnished free. These papers, written in clear and concise language, as free as possible from technicalities, are much superior to ordinary text-books on the subjects of which they treat. In addition, special information regarding any difficulties in their studies is furnished students without extra charge. It should be the ambition of every man to advance in his trade or profession. A mechanic with practical experience supplemented by theoretical education, can command a better position than a man without such an education. The result of long experience in teaching by mail show that no other method so fully meets the requirements of men who have but little time for study.

NEW SHOPS OF THE LUNKENHEIMER COMPANY.

The new machine shop building which the Lunkenheimer Company has just completed is situated on the block bounded by Tremont, Waverly and Lawnway Streets, Fairmount, Cincinnati. This building is 90 ft. wide by 170 ft. long, with two stories and basement and is built on the usual machine-shop gallery style of construction. There is a traveling crane 30 ft. wide which runs the full length of the building, leaving galleries on the second floor, on both sides, 30 ft. wide. The construction is of steel throughout and designed to safely carry a load of 300 lbs. per square foot. This building was erected for the purpose of taking care of three important departments of the company, viz.: iron valves, injectors and safety valves. It is, strictly speaking, a model machine shop and is equipped throughout with the very latest tools and appliances for producing the articles mentioned above. The steam plant consists of a 125-H. P. special Babcock & Wilcox boiler built for a safe working pressure of 400 lbs. per square inch. In connection with this boiler there are a number of appliances for testing devices under steam, air and hydraulic pressure. The building is lighted by electricity and the power is furnished by a 100-H. P. engine. The exterior of the building presents a very handsome appearance, being pressed brick throughout. The location is an excellent one for manufacturing, railroad facilities are ample, and a track spur from the C. H. & D. railroad leads to one side of the building. The erection of this building will not, in any way, reduce the building now occupied by the company on East Eighth Street, Cincinnati, which will hereafter be entirely devoted to brass work. The company contemplates the erection of a large building on some other property which they own, which is adjacent to the new building, but it is not likely that this will be carried out for another year. By the erection of this new building the manufacturing facilities have been increased about 25 per cent. and employment is given to 100 men in addition to the force already operated, bringing the total force up to 500 hands.

New Machine Shop.—The Lunkenheimer Company.

No. 12.
Vol. LXXIV.

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Sixty-Ninth Year.
Established 1832.

NEW YORK:
Morse Building, 140 Nassau Street.

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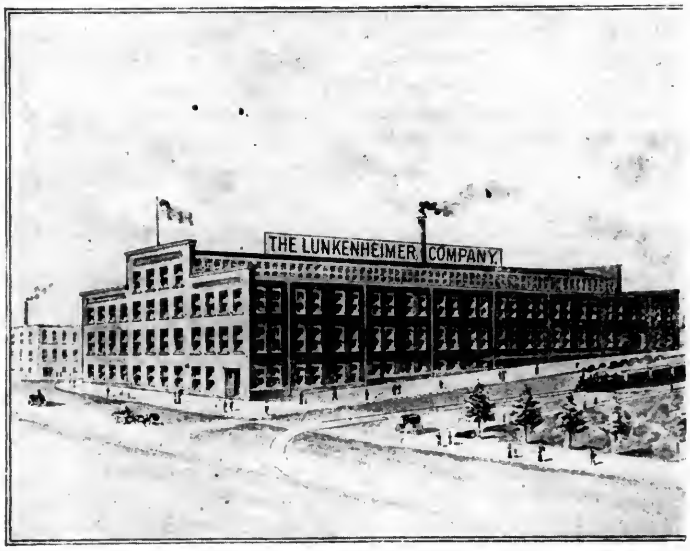

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Represents the Essentials in Bearing Metals.

An Alloy of Copper, Tin and Lead, Combined by Our Patent Process Into a Homogeneous Bearing Metal.

Elaborate Service Tests by the Pennsylvania Railroad showed that:

1. Copper-tin alloy gives 50 per cent. more wear than standard phosphor bronze.
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3. Increase of lead decreases wear.
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From years of concentrated experience and study of the Economics of Bearing Metals, we have a process whereby we are enabled to produce, free from segregation, alloys of lead and copper in any desirable proportions, and our tests of alloys containing above 15 per cent. of lead fully confirm the predictions of the Pennsylvania Railroad tests.

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Metal Tested.	Copper.	Tin.	Lead.	Relative Wear.
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Arsenic Bronze, "A"	89.20	10.00	. .	1.42
" " "B"	82.20	10.00	7.00	1.15
" " "C"	79.70	10.00	9.50	1.01
Standard Phosphor Bronze	79.70	10.00	9.60	1.00
Bronze, "K"	77.00	10.50	12.50	.92
" "B"	77.00	8.00	15.00	.86

TESTS IN OUR OWN LABORATORY.

Metal Tested.	Copper.	Tin.	Lead.	Relative Wear.
Standard Phosphor Bronze	79.70	10.00	9.60	1.00
Ajax Plastic Bronze, "A"	73.00	5.00	21.00	.67
" " " "B"	64.00	5.00	30.00	.30½
" " " "C"	48.00	. .	47.00	.16½

We find (1) an almost constant relation between plasticity and wear, (2) less friction, and (3) lower running temperature than that of Standard Phosphor Bronze.

We are prepared to give a SUBSTANTIAL GUARANTEE of 100 per cent. saving in cost, over all other known bearing bronzes, WILL REPLACE, FREE OF COST, all bearings running hot, and at the same time sell our alloy at a MANUFACTURER'S PROFIT ONLY.

Those about to make yearly contracts will find our proposition and figures attractive.

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2200 WASHINGTON AVE PHILADELPHIA.
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INGOTS CASTINGS WIRE RODS SHEETS ETC.
— DELTA METAL —
CASTINGS, STAMPINGS AND FORGINGS
ORIGINAL AND SOLE MAKERS IN THE U.S.

DELTA

The Lunkenheimer
"99" MODEL
Standard Injector

Universally Applicable

This machine is warranted to show in actual service results hitherto unattainable with any other make of injector on the market. With feed water at 75° F. Lift 6 ft., it will work **without adjustment of steam or water at all pressures from 40 to 250 lbs. and higher, and the capacity can be graded over 50 per cent. at any point** in that range of work. Note carefully **all conditions are mentioned** in this statement.

The construction is simple and free from all complicated mechanism. All parts are easily accessible and tubes are very durable. In grading the capacity, the steam supply is cut down in proportion to the water, hence the discharge is cool and scale is not liable to form.

It is thoroughly reliable and can be started promptly under the most extreme conditions, and **unlike** many others its efficiency is not confined to any particular season of the year. The capacity increases with the pressure. A trial is solicited and satisfaction guaranteed.

Write for Catalog of Superior Brass and Iron Steam Specialties.

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26 Cortlandt Street, New York.
35 Great Dover Street, London.

THE LUNKENHEIMER CO., SOLE MAKERS AND PATENTEES.
Main Offices and Works Cincinnati, O., U. S. A.

THE ACME MACHINERY CO.

CLEVELAND, OHIO,

MANUFACTURERS OF

Single, Double and Triple

Automatic Bolt Cutters, Bolt Headers, Etc.

Also Separate Heads and Dies.

Write to us for anything you want in this line.

Heat that cannot be measured.

Carborundum is made in the largest electrical furnace in the world—producing a heat so great that it has never been measured—Manufactured diamonds—that's what

CARBORUNDUM

really is—Its diamond like hardness, and brittleness, and sharpness give it its fast cutting and long lasting qualities—enable it to do more work, and better work, than any other abrasive on earth.

Carborundum wheels are guaranteed to save money to their users.

The Carborundum Company,
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BOUND VOLUMES FOR 1900 ✤ ✤ ✤ PRICE $3.50

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THOMAS NOLAN
SUCCESSOR TO
CHARLES F. KETCHAM & CO.,
STATIONERS,
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ENGINEERS' MATERIALS,
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The only substitute for Leather that wears better than the hide itself. Is not affected by heat or cold; can be washed and will not scratch or peel.

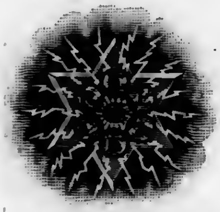
THE NEW YORK LEATHER & PAINT COMPANY,

339 BROADWAY, NEW YORK, N. Y.

THE WESTERN AGENCIES COMPANY, San Francisco, Cal.
Sole Agents for the Pacific Slope.

The Consolidated "Axle Light" System

......OF......



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FOR ALL KINDS OF

Railway Passenger Cars.

Electricity generated from the car axle while the car is in motion and supplied automatically from a storage battery when the car is stationary.

Each car carries its own electric lighting and ventilating apparatus, being entirely independent of all other cars and of any distant stationary plant.

Electric Lights and Fans keep a car bright and cool and avoid all discomfiture from heat, smoke and glare and all danger from fire or explosions where gas or oil lamps are used.

The "Axle Light" equipment is automatic and self-regulating in its operation and, therefore, its cost of maintenance is insignificant when compared with the expense incurred by Railway Companies using gas or oil lamps in passenger cars.

SEND FOR OUR ILLUSTRATED CATALOGUE.

Consolidated Railway Electric Lighting and Equipment Company,

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J. L. WATSON, Secretary and Treasurer.

JNO. T. DICKINSON, General Agent.

Vice-President and General Manager.

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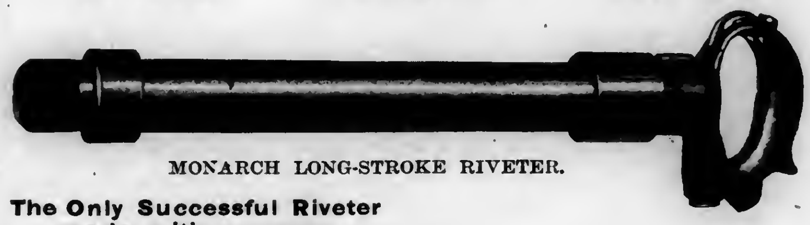

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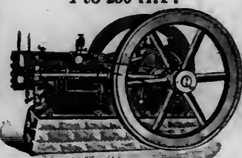

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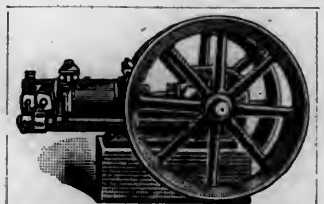

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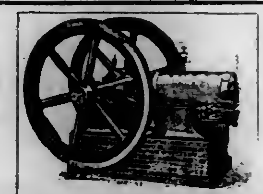

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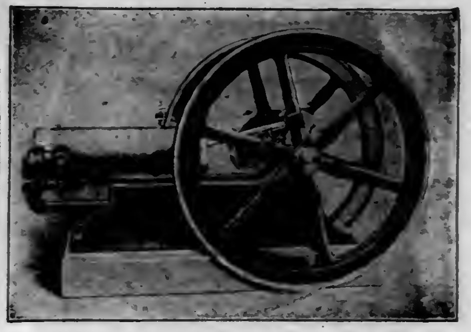

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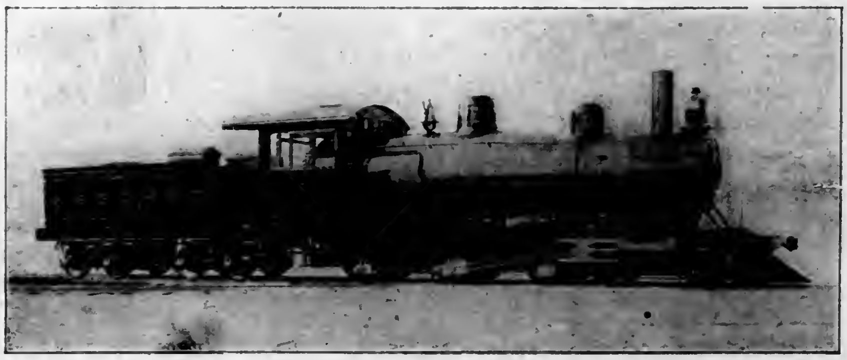


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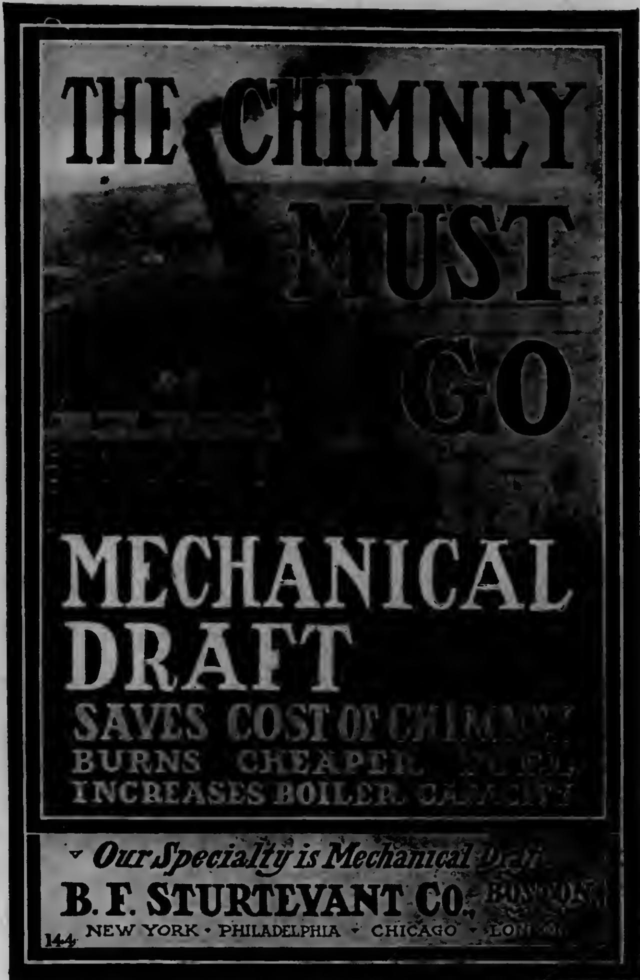

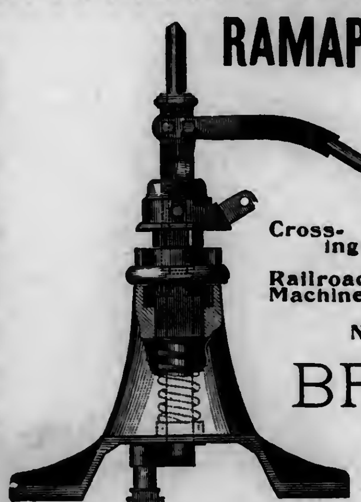

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